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EPIDEMIC ENCEPHALITIS (ENCEPHALITIS LETHARGICA)

REPORT OF AN OUTBREAK OCCURRING IN THE PHILIPPINE ISLANDS
WITH NOTES ON THE PATHOLOGICAL FINDINGS

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FIVE PLATES AND ONE TEXT FIGURE

INTRODUCTION

Epidemic encephalitis (encephalitis lethargica) has occupied such a prominent place in medical literature during the past five years, since the original report by von Economo⁽²³⁾ of an epidemic in Vienna, presenting the syndrome now associated with that disease, that any detailed historical consideration at this time would be redundant. In a general way, as Flexner⁽¹⁰⁾ pointed out, the disease spread from Austria over continental Europe during the winter of 1917 and 1918 and reached America on its eastern shores shortly after. From there it passed rapidly across the United States during that year and then gradually disappeared in pandemic form, only sporadic and scattered cases being reported here and there. Almost coincidentally with the Viennese outbreak, Cleland and others⁽⁶⁾ reported a somewhat similar disease in Australia which was termed "X" disease or acute encephalomyelitis. In the Philippine Islands a few atypical cases were noted during 1918 and 1919, three of which were corroborated by autopsy and reported by de

Leon.⁽⁸⁾ At no time did the conditions here assume the proportions of an epidemic, even in Manila.

The other feature of general interest associated with the development of this pandemic has been its possible relationship to influenza, as it closely followed in the wake of that disease. Indeed, the literature teems with theoretical expositions of the unquestionable etiological basis of influenza; but several investigators feel that this relationship is merely one of coincidence and not of cause and effect. Personally, I am of this group, and I feel my stand has been somewhat strengthened by the recent outbreak of encephalitis in Manila, which occurred without any apparent preceding influenza epidemic.

In this connection one's opinion must be largely formed by impression and statistics, both of which notoriously may be in error. Unfortunately, statistics for the Philippine Islands as a whole are incomplete, and I am forced unwillingly to refer to those of the city of Manila as representative. Figures are available in the annual reports of the Philippine Health Service which conclusively show the relative annual incidence of influenza, as this disease has been reportable for a number of years. In Manila, a city of approximately 300,000 people, there are ordinarily reported less than 300 cases of influenza annually. Such has been the case for the past seven years, with the exception of 1918, when the number reached nearly 40,000. The final figures for 1922 are not yet complete, but a preliminary examination indicates no noteworthy increase in the incidence of influenza. Allowing for the natural errors of diagnosis in a respiratory-tract disease presenting so variable a clinical picture, we should probably agree that these figures at least represent its relative incidence.

The chief points to be noted are the facts that since the epidemic of influenza in 1918 and 1919 the disease has been present only in sporadic form and that from then to the present no epidemic of encephalitis has been noted in either of two of the largest hospitals, the Philippine General Hospital and the San Lazaro Public Health Service Hospital.

Then suddenly, early in November, 1922, without any apparent coincidental increase of influenza, and occurring usually in individuals with no previous history of influenza, either recently or in 1918, there developed an epidemic of a nervous disorder related very closely in appearance to the so-called myoclonic and choreiform types of epidemic encephalitis. This progressed steadily, reaching its peak about the middle of January, 1923,

and has tended to decrease since that time. It is too early to obtain the final statistics from the records of the Philippine Health Service, and my statements are based largely on the incidence of the cases in the two aforementioned hospitals where I personally had an opportunity of checking the clinical diagnosis fairly regularly at autopsy, either by performing the necropsy personally or by studying the material histologically.

The more complete epidemiological studies will probably be presented later. However, a few general facts are not out of place here. The disease as it occurred in these hospitals was a disease chiefly of adult males. The spread of the infection has been as mysterious as that of anterior poliomyelitis or influenza itself. The first case seen in Manila was in a sailor on one of the interisland boats, in November, 1922. From that time it spread very widely, apparently without direct contact, as this patient was removed from the boat to a hospital where he died within a few days. The cases were found in all parts of the city—in only one instance two were in the same family or house—usually scattered here and there through the various sections of the town. It affected the different classes of society about proportionally, but the individuals were usually males from 18 to 30 years of age. Isolated cases from as far as 80 kilometers away were brought to the hospital, with no history of exposure that could be ascertained.

Mortality is high; in the group of cases from the Philippine General Hospital there were thirteen deaths in which autopsy confirmed the diagnosis, and there were three probable cases in which autopsy was refused. Several other cases were originally tentatively included clinically, but autopsy revealed tuberculous meningitis, cerebral hæmorrhage, typhoid meningismus, etc., as the case might be. Recovery in a case presenting characteristic symptoms usually was considered positive evidence, as eliminating tuberculous meningitis as the chief single source of diagnostic errors; of the hospital cases which we can consider fairly definitely clinically as epidemic encephalitis there was a total of 33 with 16 deaths, a mortality of 48.4 per cent.

In addition to these sixteen cases I was privileged in performing three autopsies on cases dying in other hospitals, the bodies of which were transferred to the City Morgue for post-mortem examination. I also had the opportunity of witnessing the necropsy of a case from the Sternberg General Hospital, United States Army, besides seeing the histological preparations from two other cases from that institution. Furthermore, I received

the coöperation of several physicians and was thus enabled to see several other cases clinically and secure laboratory data upon them. Through their kindness, likewise, I have been able to secure the data from several Manila and provincial hospitals concerning the incidence and mortality in those places. So far as I am aware, only two towns of any considerable size outside of Luzon have suffered from the epidemic; these are Zamboanga and Cebu. The latter had only two cases clinically, both of which recovered. These occurred at the same time that the epidemic appeared in Manila, although Cebu is nearly 640 kilometers farther south and completely isolated from there except by boat.

In Zamboanga, on the other hand, which is about 960 kilometers south of Manila, the disease did not appear until March, some time after the peak of the Manila outbreak had been reached. There were thirteen cases in the hospital, in general of a somewhat milder form. I had the good fortune to see all of these cases but one, which had died and on which an autopsy had been performed by Dr. C. Manalang. I understand from a communication from him that one more of the cases has since terminated fatally. A discussion of the outbreak there is being published by Doctors Manalang and Rodriguez, of the Philippine Health Service. (17)

Table 1 shows the incidence and the mortality as completely as I have been able to secure the information to date. It is obviously very incomplete from the epidemiological standpoint, but will I think tend to show the epidemic character of the disease and its apparent independence of influenza. The epidemiological and clinical aspects of the epidemic will be reported by other members of the hospital staff and health service, so I shall confine my attention in so far as possible to the more purely laboratory side.

Text figure 1 is an attempt to show, with the data available at the present writing, the morbidity and the mortality for Manila, month by month. I am indebted to Dr. Vicente de Jesus, director of the Bureau of Health, for permission to use these figures. The final statistics will appear in the annual health report, but these figures give us a very satisfactory picture of the relative course of the epidemic.

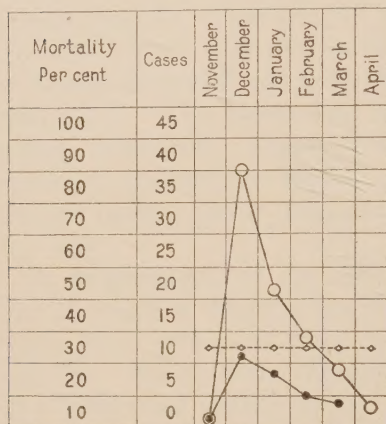
It is interesting perhaps also to analyze briefly some of the other statistical information we have at hand. In the thirty-six cases from the Philippine General Hospital the average duration for all the cases, from the time of onset of the disease as ac-

TABLE 1.—Morbidity and mortality of epidemic encephalitis.

| Hospital. | Cases. | | | Age. | | | Previous history of influenza. | Deaths. | | | Mortality. |
|------------------------|--------|---------|--------|-----------|---------|----------|--------------------------------|---------|---------|--------|------------|
| | Male. | Female. | Total. | Youngest. | Oldest. | Average. | | Male. | Female. | Total. | |
| | | | | Years. | Years. | Years. | | | | | Per cent. |
| Philippine General | 24 | 9 | 33 | 3 | 41 | | (?) | 15 | 1 | 16 | 48.4 |
| San Lazaro | | | | | | | | | | | |
| Chinese General | 2 | 1 | 3 | 19 | 49 | 34 | 0 | 1 | 1 | 2 | 66.6 |
| San Juan de Dios | 7 | 0 | 7 | 16 | 40 | | 0 | 2 | 0 | 2 | 28.5 |
| Saint Paul's | 3 | 1 | 4 | 21 | 49 | 32 | 0 | 0 | 1 | 1 | 25 |
| Mary J. Johnston | 0 | 1 | 1 | | | 26 | 0 | 0 | 0 | 0 | |
| Mary Chiles | | | | | | | | | | | |
| Bilibid Prison | 1 | 0 | 1 | | | 23 | 0 | 1 | | 1 | 100 |
| Sternberg General | 6 | 0 | 6 | 27 | 42 | 34.2 | 0 | 5 | 0 | 5 | 83.3 |
| Hospital Español | 0 | 0 | 0 | | | | | 0 | 0 | 0 | |
| Average | | | | | | | | | | | |
| Zamboanga General | | | 13 | | | | | | | 2 | 50.2 |
| Southern Islands, Cebu | | | 2 | | | | | | | 0 | 15.5 |

curately as could be ascertained by the history to the time of discharge, is given in Table 2. The cases are further grouped to show the duration of the fatal ones in contrast to those that

recovered and in Table 3 will be found similar information from some of the other hospitals. By giving each of these groups a relative value, dependent on the number of cases, a general average has also been obtained for the fatal cases.



○—○ Morbidity cases.
 ●—● Mortality cases.
 ◇—◇ Mortality average, 34.9 per cent.

FIG. 1. Morbidity and mortality of epidemic encephalitis in Manila for three months in 1922 and three months in 1923.

These body fluids yielded very little information, either from the point of view of diagnosis or from that of prognosis, except in a negative way. The urine is probably the least valuable in

SCOPE
 This work is based chiefly on the histological examination of material obtained at autopsy from the fatal cases. In addition it includes observations on the clinico-pathological laboratory findings of the blood, urine, and spinal fluid of many of the cases that recovered.

TABLE 2.—Showing the age incidence and the duration of the disease; complete data on thirty-three cases.

| Cases. | Average age. | Average duration. |
|------------------------------------|--------------|-------------------|
| | Years. | Days. |
| Males and females | 25.8 | 40 |
| Males and females, fatal cases | 24.7 | 16.5 |
| Males and females, recovered cases | 21 | 63.6 |
| Males, 24 cases | 25 | 37 |
| Males, fatal, 15 cases | 25 | 14.5 |
| Males recovered, 9 cases | 25.7 | 75.6 |
| Females, 9 cases | 16.3 | 51 |
| Females, fatal, 1 case | 20 | 45 |
| Females recovered, 8 cases | 15.8 | 51.7 |
| Youngest case, female | 2.3 | 77 |
| Oldest case, male | 53 | (?) |
| Shortest duration case, male | 25 | 5 |
| Longest duration case, male | 19 | 142 |

TABLE 3.—*Showing relative duration of disease in fifty-four cases on which data have been supplied. Averages are obtained by crediting the figures on their percentage of the total number of cases.*

| Hospital. | Cases. | Average duration in days. | | | | | |
|-------------------------|--------|---------------------------|--------|------------|--------|----------|--------|
| | | All cases. | | Recovered. | | Fatal. | |
| | | Ac-tual. | Value. | Ac-tual. | Value. | Ac-tual. | Value. |
| | | | P. ct. | | P. ct. | | P. ct. |
| Philippine General..... | 33 | 40 | 29.2 | 63.6 | 53.8 | 16.5 | 10.4 |
| San Juan de Dios..... | 7 | 40.6 | 6.8 | | | 35 | 4.5 |
| Sternberg General..... | 6 | | | 33 | 24 | 15.6 | 1.7 |
| Saint Paul's..... | 4 | 40 | 3.5 | | | 25 | 1.8 |
| Chinese General..... | 3 | | | | | 16 | 0.8 |
| Mary J. Johnston..... | 1 | 55 | 1.3 | | | | |
| Total..... | 54 | | 40.8 | | 77.8 | | 19.2 |

this connection. Table 4 gives the results of urine examination in the cases from the Philippine General Hospital in which urinalysis was done, diagnosed as encephalitis. In some cases several examinations were made, and in preparing this table I have endeavored to utilize the most pathological specimen to emphasize the very slight importance which can be attached to such examination in this disease.

It will be noted that very few cases show even the slightest possible trace of albumin. This is not surprising in view of the fact that the temperature rarely reaches 39° C. (occasionally as a terminal rise), and thus febrile albuminuria, which is a feature of many disease processes, is lacking. The microscopic examination likewise is negative from the point of view of pathogenic evidence, the rare cast or pus cell being parallel with the albumin and usually evidence of previous kidney disease.

In the same way the blood findings are of very little significance. In Table 5 I have attempted to analyze the blood picture. It will be seen that the white count varies considerably, ranging from about 4,000 to 30,000.(14) This seems to be dependent upon some factor other than the nonsuppurative central nervous infection alone, for in entirely uncomplicated cases we note at most only a very slight rise. In cases where definitely visible hæmorrhagic areas occur in the nervous tissues the tendency is, possibly, for the white count to rise slightly, dependent presumably on the toxic absorption of the necrotic tissue. This is not necessarily of prognostic value, as many of the fatal cases

TABLE 4.—*Showing results of urine examination of Philippine General Hospital cases^a diagnosed as encephalitis.*

| Serial No. | Hospital No. | Sex. | Age. | Color. | Transpar- ency. | Reaction. | Albumin. | Sugar. | Sediment. |
|------------|--------------|------|---------|--------|--------------------|-----------|-------------------|----------|-----------------------|
| 1. | 103333 | M. | Yrs. 22 | Pale | Clear | Acid | Negative | Negative | Negative. |
| 2. | 103408 | M. | 19 | Amber | do. | do. | do. | do. | Do. |
| 3. | 103610 | M. | 41 | do. | Turbid | do. | Slight trace | do. | Occasional cast. |
| 4. | 103660 | M. | 27 | Straw | Clear | do. | Negative | do. | Negative. |
| 5. | 103800 | M. | 17 | Pale | Cloudy | do. | Very slight trace | do. | Do. |
| 6. | 104161 | M. | 24 | Amber | do. | Alkaline | Negative | do. | Do. |
| 7. | 104312 | M. | 21 | do. | Clear | Acid | Slight trace | do. | A few granular casts. |
| 8. | 104540 | M. | 19 | do. | Cloudy | do. | Very slight trace | do. | Do. |
| 9. | 104686 | M. | 37 | do. | Clear | do. | Negative | do. | Negative. |
| 10. | 106087 | F. | 20 | Pale | do. | do. | do. | do. | Do. |
| 11. | 106221 | M. | 41 | Amber | Cloudy | do. | do. | do. | Do. |
| 12. | 106277 | F. | 23 | Pale | Clear | do. | do. | do. | Do. |
| 13. | 107439 | M. | 28 | Dark | do. | Alkaline | Very slight trace | do. | Do. |

^a The records of the other cases are either incomplete or lacking. The albumin is only occasional and apparently dependent on fever or previous kidney disease.

show no reaction of the bone marrow whatsoever, as evidenced by the examination of the peripheral blood.

The differential count likewise gives us little information, except that there is some relative increase in the polynuclear percentage, which is of some significance, for it must be remembered that the normal percentage value of the lymphocytes among Filipinos is high, in contrast to the American or the European. We should not expect the red cells and hæmoglobin to show any change, and in the cases where such examinations were made, nothing of significance was noted. Similarly, the coagulation and bleeding times showed no pathological variation in several cases examined.

TABLE 5.—*Blood findings in encephalitis.*

| Serial No. | Hospital No. | Sex. | Age. | Red cells per cubic millimeter. | White cells per cubic millimeter. | Hæmoglobin. | Differential count. | | | |
|------------|--------------|------|-------------|---------------------------------|-----------------------------------|---------------|---------------------|--------------|---------------|-------------|
| | | | | | | | Neutrophiles. | Lymphocytes. | Eosinophiles. | All others. |
| | | | <i>Yrs.</i> | | | <i>P. ct.</i> | | | | |
| 1 | 102946 | F. | 12 | ----- | 15,600 | ----- | 74 | 25 | 0 | 1 |
| 2 | 103333 | M. | 22 | ----- | 16,000 | ----- | 59 | 35 | 2 | 4 |
| 3 | 103341 | F. | 20 | ----- | 10,000 | ----- | 87 | 11 | 0 | 2 |
| 4 | 103361 | M. | 22 | ----- | 8,400 | ----- | 58 | 35 | 4 | 3 |
| 5 | 103408 | M. | 19 | ----- | 14,800 | ----- | 81 | 12 | 6 | 1 |
| 6 | 103610 | M. | 41 | ----- | 10,200 | ----- | 85 | 15 | 0 | 0 |
| 7 | 103660 | M. | 27 | ----- | 9,000 | ----- | 82 | 18 | 0 | 0 |
| 8 | 104019 | F. | 13 | ----- | 5,200 | ----- | 90 | 10 | 0 | 0 |
| 9 | 104020 | M. | 20 | ----- | 11,500 | ----- | 71 | 27 | 1 | 1 |
| 10 | 104035 | M. | 22 | ----- | 11,600 | ----- | 76 | 21 | 2 | 1 |
| 11 | 104156 | M. | 31 | ----- | 20,800 | ----- | 92 | 8 | 0 | 0 |
| 12 | 104161 | M. | 24 | ----- | 21,000 | ----- | 75 | 21 | 1 | 3 |
| 13 | 104299 | M. | 15 | ----- | 10,200 | ----- | 75 | 22 | 1 | 2 |
| 14 | 104312 | M. | 21 | 4,000,000 | 10,200 | 75 | 79 | 18 | 0 | 3 |
| 15 | 104458 | M. | 41 | ----- | 11,200 | ----- | 80 | 18 | 0 | 2 |
| 16 | 104540 | M. | 19 | ----- | 27,200 | ----- | 84 | 12 | 1 | 3 |
| 17 | 104635 | F. | 15 | ----- | 10,000 | ----- | 89 | 9 | 0 | 2 |
| 18 | 104686 | M. | 37 | ----- | 8,600 | ----- | 85 | 12 | 2 | 1 |
| 19 | 104764 | M. | 18 | 3,190,000 | 7,800 | 70 | 76 | 22 | 1 | 1 |
| 20 | 104850 | M. | 25 | ----- | 9,800 | ----- | 86 | 11 | 1 | 2 |
| 21 | 104958 | F. | 13 | ----- | 7,200 | ----- | 70 | 30 | 0 | 0 |
| 22 | 105905 | M. | 3 | ----- | 16,400 | ----- | 88 | 11 | 1 | 0 |
| 23 | 106087 | F. | 20 | ----- | 8,000 | ----- | 83 | 17 | 0 | 0 |
| 24 | 106221 | M. | 41 | 3,900,000 | 5,000 | 75 | 87 | 12 | 0 | 1 |
| 25 | 106277 | F. | 23 | 4,190,000 | 10,000 | 80 | 78 | 21 | 1 | 0 |
| 26 | 106565 | F. | 2 | ----- | 9,000 | ----- | 66 | 34 | 0 | 0 |
| 27 | 106766 | F. | 31 | 3,350,000 | 7,800 | 65 | 51 | 43 | 5 | 1 |
| 28 | 107439 | M. | 28 | ----- | 10,000 | ----- | 86 | 10 | 0 | 4 |
| Average | | | | ----- | 11,553 | ----- | 78.4 | 19.3 | 1.0 | 1.3 |

The findings of the spinal fluid are of the most value diagnostically, from the laboratory point of view. However, they are of more interest from the negative than from the positive viewpoint. As will be noted by an examination of Table 6, two rather constant findings are recorded. One of these is a noticeable increase in the reduction of Fehling's solution, and the other is a very low cell count, usually under 20 per cubic millimeter. The spinal fluid in general may be said to show slightly increased pressure (in about 70 per cent of the cases where it was recorded), to have a nearly normal cell count, rarely to contain demonstrable globulin, and to possess an in-

TABLE 6.—*Spinal-fluid examinations.*

[0, no reduction; —, normal reduction; +, appreciable increase in reduction; ++, marked increased reduction.]

| Serial No. | Hospital No. | Sex. | Age. | Protein. | Sugar. | Cell count per cubic millimeter. | Differential count. | | Clinical outcome. |
|--------------|--------------|------|------|----------------------|-----------|----------------------------------|---------------------|----------------|-------------------|
| | | | | | | | Poly-nu-clears. | Lym-pho-cytes. | |
| | | | Yrs. | | | | P. ct. | P. ct. | |
| 1 | 102946 | F. | 12 | — | — | 6 | — | — | Improved. |
| 2 | 103333 | M. | 22 | — | — | 20 | — | (*) | Do. |
| 3 | 103341 | F. | 20 | Very slight trace... | — | 20 | — | — | Died. |
| 4 | 103361 | M. | 22 | do..... | + | 5 | — | (*) | Improved. |
| 5 | 103408 | M. | 19 | Slight trace..... | ++ | 7 | — | (*) | Recovered. |
| 6 | 103660 | M. | 27 | Trace..... | + | 7 | — | (*) | Do. |
| 7 | 103800 | M. | 17 | Negative..... | + | 8 | — | — | Died. |
| 8 | 104019 | F. | 13 | Slight trace..... | 0 | 5 | — | (*) | Recovered. |
| 9 | 104035 | M. | 22 | — | + | 10 | — | (*) | Improved. |
| 10 | 104156 | M. | 31 | Negative..... | ++ | 5 | — | — | Died. |
| 11 | 104161 | M. | 24 | Very slight trace... | ++ | 8 | 20 | 80 | Do. |
| 12 | 104299 | M. | 15 | — | 0 | 7 | — | — | Recovered. |
| 13 | 104312 | M. | 21 | Trace..... | ++ | 30 | — | (*) | Died. |
| 14 | 104540 | M. | 19 | Negative..... | + | 7 | — | — | Do. |
| 15 | 104635 | F. | 15 | — | — | 3 | — | (*) | Recovered. |
| 16 | 104686 | M. | 37 | Negative..... | Negative. | 2 | — | — | Died. |
| 17 | 104764 | M. | 18 | — | + | 32 | — | — | Do. |
| 18 | 104850 | M. | 25 | Negative..... | + | 2 | — | — | Do. |
| 19 | 104958 | F. | 13 | Slight trace..... | ++ | 6 | — | (*) | Improved. |
| 20 | 105844 | M. | 15 | Trace..... | ++ | 10 | — | (*) | Died. |
| 21 | 105905 | M. | 3 | Negative..... | + | 10 | — | — | Do. |
| 22 | 106087 | F. | 20 | do..... | + | 3 | — | — | Improved. |
| 23 | 106221 | M. | 41 | Slight trace..... | ++ | 5 | — | — | Recovered. |
| 24 | 106277 | F. | 23 | Very slight trace... | + | 7 | 5 | 95 | Do. |
| 25 | 106565 | F. | 2 | Slight trace..... | ++ | 20 | 10 | 90 | Do. |
| 26 | 106766 | F. | 31 | Very slight trace... | + | 2 | — | — | Improved. |
| 27 | 107439 | M. | 28 | Slight trace..... | ++ | 40 | — | — | Died. |
| Average..... | | | | | | 10.6 | | | |

* Predominance.

creased sugar content as evidenced by its ability to precipitate the copper salts. These findings are in accord with those of other investigators, among whom may be cited Ayer,(3) Hodges,(12) and Thalheimer.(22)

PATHOLOGY

The pathology of the disease is well defined. It has been so thoroughly described by numerous workers (8, 16, 11, 13, 15, 20, 2, 7, 18) that I shall endeavor to condense the findings in these cases as much as possible to a simple tabular form, and merely give a composite description of the essential changes. As has been often emphasized, the term encephalitis lethargica is an unfortunate one—a symptomatic descriptive phrase, which applies either to a relatively small number of the cases or simply to a single phase of the disease. From the pathological standpoint a more-inclusive anatomical name such as the occasionally used “encephalomyelitis” or “polioencephalomyeloneuritis” would be more appropriate, (19, 5, 1) as the lesions are by no means confined to the encephalon. Indeed, in this group of cases, the floor of the fourth ventricle, the medulla, the cervical cord, and spinal ganglia showed much more marked lesions than the motor cortex or other portions of the cerebrum or cerebellum.

A routine method for the examination of these bodies was adopted in an effort to standardize the data. This consisted in the preliminary opening of the spinal column and skull and the sterile removal of the spinal cord in its entirety for animal inoculation and bacteriologic studies. Following the utilization of such material as was needed, the rest of the cord and the brain were sectioned and blocks cut from comparative portions. In general, sections were removed in order from the motor cortices, the sensory cortices, the corpora striata, the cerebellar peduncles, through several portions of the brain stem, from the cervical, thoracic, and lumbar levels of the spinal cord and, in a few cases, from spinal ganglia in the thoracic region. They were cut from 2 to 4 millimeters in thickness and fixed in (a) Zenker's fluid, (b) 10 per cent formalin, and (c) Carnoy's fluid for the demonstration of nerve fiber and cell degeneration, according to the technic of Maj. George R. Callender, of the United States Army Medical Research Board in Tropical Medicine.

Following the removal of the central nervous system a routine examination of the other viscera was made, and sections from all the organs preserved for microscopic study. The gross find-

ings were nearly constant and, while the changes grossly were only slight (in view of the clinical history), very little difficulty was had in making a tentative anatomical diagnosis. The following is the report of an autopsy protocol which has been chosen almost at random, so closely do the findings in general coincide:

Autopsy 9527.—Body is that of a well-developed, well-nourished, female Filipino, 20 years old, measuring 145 centimeters in length and weighing 30.9 kilograms. Rigor mortis is marked, particularly in the abdominal muscles. There is slight post-mortem lividity in the dependent portions. There is no œdema. The eyes are not shrunken, the scleræ are clear, and the pupils are regular and equal. The mouth is in fair condition. Chest is symmetrical. Abdomen is sunken and scaphoid. External genitalia are negative. Superficial lymph nodes show enlargement. The skin is essentially negative, except for a small scar in the right axillary line anteriorly.

The abdominal wall contains 2 or 3 centimeters of a deep yellowish fat; the musculature is normal in color and consistency. Peritoneal cavity contains neither free fluid nor adhesions. The omentum is negative. The appendix measures 5 centimeters in length, is retrocecal in position, and normal in appearance. Mesenteric lymph nodes show no enlargement. The diaphragm reaches the fourth interspace on the right and the fifth rib on the left. Mediastinum is negative, although there is an atrophic thymic raise present.

Pleural cavities contain no free fluid and no adhesions. Pericardial cavity is negative.

The heart weighs 137 grams. The myocardium is deep brownish red and shows marked congestion. The coronary vessels likewise are congested and prominent. The endocardium is smooth and glistening. There are no valvular defects. Valve measurements: Tricuspid, 10.8 centimeters; pulmonary, 6.8; mitral, 8.5; aortic, 6.2; left ventricle, 1.3; right ventricle, 0.3.

The lungs are entirely negative except for slight hyperplastic congestion in the posterior portion, particularly at the base. The hilus lymph nodes are negative.

The spleen weighs 50 grams. It is small. Its capsule is slightly wrinkled. On section the follicles are barely visible as minute grayish white pin-point areas. The pulp is moderately congested and there is a relative increase of connective tissue in the trabeculæ, giving a firm consistency to the organ. The appearance is one of simple atrophy.

The liver weighs 610 grams. Its capsule is smooth and glistening. It is pale and somewhat mottled in appearance. This is distinctly small and again suggests an atrophic condition. On section moderate fatty change of the liver parenchyma is noted. No actual central necrosis is seen. There is no increase of connective tissue visible and there is no bile stasis. Gall bladder and ducts are negative.

The pancreas weighs 63 grams and shows no gross change. Alimentary tract: Stomach is small and atrophic. Its mucosa is negative. The small intestine measures 595 centimeters in length and is negative except for the presence of an ascaris worm. Lymphoid tissue and ileum show no

hypertrophy, and nothing to suggest typhoid infection. The large intestine measures 175 centimeters and is entirely negative.

Adrenals: The right weighs 10 grams and the left 12. Except for relative hypertrophy they show no gross change.

Kidneys: The right weighs 80 grams and the left 90. They are extremely congested. Their capsules strip readily, leaving a deep red congested smooth surface. On section the cortical medullary demarcation is sharp. The calyces and pelves appear negative. Ureters and bladder are normal.

Genitalia: The uterus is apparently in the early congested period of menstrual cycle and the ovaries likewise show marked congestion. There is a small corpus luteum measuring 4 millimeters in diameter in the tip of the left ovary.

The organs of the neck are negative.

The brain is removed and weighs 1,162 grams. There are moderate œdema and congestion of the meninges and of the brain tissue itself. Section through the corpus striatum shows very distinct focal areas of degeneration with barely visible petechial hæmorrhages. There are less-marked degenerative changes visible in the medulla, pons, and in the region of the dentate nucleus of the cerebellum. The vessels in these areas are intensely congested, and a few places suggest capillary hæmorrhages. The spinal cord is removed and marked congestion and œdema again are noted. This is most marked in the gray matter of the cord in both the posterior and anterior horns. The most-marked lesions in the upper portion of the cord show fecal areas of degeneration with petechial hæmorrhages.

The aorta shows no atheromatous changes.

Duration of illness: One month and 15 days.

Clinical diagnosis: Encephalitis lethargica, myoclonic type.

Anatomic diagnosis: Encephalo-myelitis, acute; petechial hæmorrhages of corpus striatum, cerebellar dentate nucleus and both posterior and anterior horns of spinal cord; œdema and congestion of brain and meninges; generalized visceral congestion; fatty infiltration of liver.

Necropsy held thirty hours after death.

The autopsy findings, as observed grossly, are relatively insignificant. There is in general a diffuse venous congestion of the viscera, with a tendency for cardiac dilatation suggestive of a terminal toxæmia with cardiac failure. The lungs show no pathognomonic changes, but are apt to be heavy and boggy with capillary distention and œdema. The spleen varies so greatly as to make the changes noted of little significance. It is often somewhat larger than normal with prominence of the follicles, but the changes are not as constant even as those found in anterior poliomyelitis. The liver presents usually more or less congestion of the sinuses, at times increasing the size of the organ noticeably and oozing fluid freely on section. The other features are much less regular; namely, occasional fatty changes and slight central necrosis, which can perhaps be attributed to

the toxæmia of the disease. The kidneys also are very liable to be congested, but without showing definite kidney damage.

The only lesions that are in the least characteristic are those of the central nervous system; and even here, in many of the cases, they cannot be recognized without microscopic aid. Characteristically, we find a marked œdema not only of the arachnoid spaces but of the brain and spinal-cord substance itself. This gives a semitranslucent appearance to the gray matter of the brain and cord. It is particularly prominent on sectioning the cord which immediately bulges over the cut dura.

Aside from the œdema and congestion, there may or may not be visible punctate capillary hæmorrhages. These are usually found in the region of the caudate and lenticular nuclei, of the substantia nigra, of the floor of the fourth ventricle, and of the cervical cord, and are extremely minute in character.

Microscopically, likewise, the lesions are singularly uniform. In the cerebrum itself, in the region of both the motor and sensory cortices, there are seldom any demonstrable lesions beyond capillary dilatation and œdema. Occasionally a few red cells can be seen which apparently have escaped passively through the vessel wall; and occasionally there is a slight perivascular infiltration by lymphocytes, plasma cells, and rare endothelial cells.

In the mid-brain, however, including the caudate and lenticular nuclei regions, and in the substantia nigra we find much more advanced changes. Here the perivascular mantling with inflammatory cells is prominent, although it may range from a localized group of cells at one point to a complete mantling with ten or more layers of round cells. Photomicrographs show these perivascular lesions (Plates 1 and 2).

In the cervical cord there is still another feature which occurs with considerable regularity. This is the diffuse infiltration of the gray matter, especially of the posterior horns. Plate 1, fig. 2, illustrates this point particularly well.

The nerve-cell lesions vary, and as a rule are very slight. Occasionally there seems to be complete loss of function and even death of the cell, but so rarely as to attract especial notice, again quite in contrast to anterior poliomyelitis. The changes, when they do occur, are usually first of a chromatolytic type, followed by swelling of the cytoplasm and nucleus and gradual karyolysis. In exceptional instances phagocytosis of these injured nerve cells and their fibers can be noted—neuro and neuronophagy—as it has been concisely termed. These

nerve-cell changes are, I think, best studied in the sections of spinal ganglia.

The bacteriological findings in these cases are being reported in a separate paper. Suffice it to say here that morphological studies did not demonstrate any organisms in the tissues by either Giemsa or Gram-Weigert tissue staining. Cultural and inoculation methods proved more valuable in this respect.

A feature of the pathology in this particular group of cases has been an unusual skin exanthem. Of the cases from the Philippine General Hospital six have presented this picture. I do not wish to encroach on the clinician in discussing the relation of this lesion to the disease, but a few words are necessary concerning its development in order to discuss its histopathology. I have seen the lesions in four other cases, aside from this hospital group. It has always been one of the earliest objective symptoms of the cases when it occurred, and in at least three cases it was the reason for calling the physician or going to the hospital.

Characteristically, the lesions start as a dull, dusky red, macular eruption or mottling of the skin of the face and neck. This proceeds slowly downward over the trunk and upper extremities and then finally extends over the thighs, rarely getting below the knees. As the lesions develop they become discrete and punctate, almost papular in appearance, but retain their dull color. In respect to the distribution and the earliest appearance of the lesions one's first thought is measles. As they develop, however, the individual lesions, except for the color which persists as a somewhat dusky red, much more closely resemble the punctate rash of scarlatina. This stage of the lesion apparently takes from twenty-four to seventy-two hours to develop; and, while the neck lesions may become distinctly punctate and discrete, those of the trunk may just begin to show the dull mottling of the first stage.

The lesion undergoes a further development, with the formation of a tiny vesicle, not unlike the early lesion in varicella. This surmounts the papule and has almost no areola of inflammatory redness. It is only from 1 to 2 millimeters in diameter at the most, very superficial in character, and filled with what appears grossly to be a perfectly clear serum. Occasionally the vesicle becomes slightly umbilicated. It takes from forty-eight to ninety-six hours for these lesions to develop to their height, and there is the same progression from the head downward, those on the neck and shoulders appearing first. The lesions

remain in this condition usually for several days and then, gradually, the serum within the bleb is absorbed and the necrotic cornified superficial epithelium is desquamated as a fine, barely visible furfuraceous scale. Plates 3, 4, and 5 illustrate the latter stages of this rash. The photography was exceptionally difficult, owing to almost continuous involuntary myoclonic spasms of the various muscle groups.

In the literature of encephalitis which is available here, I have not been able to find any descriptions of strictly comparable skin lesions. It might readily be grouped as a disease entity, and were it not for the confirmatory evidence of "so-called" encephalitis, I should feel distinctly uncertain as to its relationship. The course of the lesions is readily divided into four periods: (a) the diffuse measleslike macular eruption, (b) the localizing scarlatina-form punctate papule, (c) the varicellalike vesicle formation, and (d) the period of desquamation.

I was fortunate in securing material from two of these cases within a short time of death and thus was able to study the histopathology of the lesions in their vesicular and desquamating stages. Unfortunately, none of the earlier lesions were examined microscopically. The vesicles are found to be absolutely superficial in character, with elevation of the cornified layer of the epithelium, the space being distended with coagulated, pink-staining, granular serum. The squamous cell layer appears entirely normal, as does the basement membrane. The normal prolongation of the epithelium into papillæ is noted, reaching well toward the corium. The sections studied were entirely free from hair follicles.

The corium itself shows dilatation of the terminal capillaries and an almost negligible amount of mononuclear perivascular infiltration. These cells are chiefly lymphocytes with an occasional eosinophile and plasma cell. No other polynuclears are seen, and no evidence of phagocytosis is noted. There is no tissue destruction or necrosis present, and no organisms are found in the deeper tissues by the commoner staining methods, such as Giemsa, Gram-Weigert, and Goodpasture's fuchsin. In one of the blebs itself a few barely visible coccoid organisms are seen, identical morphologically with the organisms obtained culturally from the central nervous system. Of course, no definite significance can be attached to such a single observation. The further discussion of the bacteriological findings will be taken up in a separate paper.

The presence of this skin eruption in relation to encephalitis of epidemic form is so striking and unusual a feature of the disease as to be worthy of some comment. The literature of encephalitis has been so profuse during the past three years that it is quite possible that I have overlooked references to a similar occurrence. Barker,⁽⁴⁾ in a paper on diagnostic criteria in epidemic encephalitis, makes no mention of it, as is the case in the reports by European observers that I have been able to obtain. There are a few instances in the literature in which comment is made on the possible relationship of herpes, poliomyelitis, and encephalitis,^(9, 21) based on the lesions of the spinal ganglia apparently. These do not accord in description with the lesions in this group of cases. Striking, too, is the preponderance of the hyperkinetic or myoclonic form of the disease in this series. Whether or not there may be some relationship in this respect is difficult to decide. This, likewise, suggests the possibility of whether these various clinical forms of the disease may not be due to different strains of the infecting organism which we are as yet unable to differentiate.

SUMMARY AND CONCLUSIONS

A report of an epidemic of so-called encephalitis lethargica, chiefly of the myoclonic form, is presented, covering personal observations on nearly fifty cases.

The epidemic was widespread in its distribution although relatively restricted in extent. A survey of the epidemiological data gives us little information as to the methods of dissemination, but apparently excludes influenza as a necessary precursor.

The clinico-pathological findings are of very little diagnostic value, except in a negative way. The spinal fluid usually shows a slight increase in its reducing ability on addition of copper salts and there is a tendency for a slight polynuclear leucocytosis in the blood picture.

The gross pathological changes are very slight, often negligible, consisting principally of generalized visceral and central nervous system congestion with occasional visible punctate hæmorrhages of the corpora striata, medulla, or cervical cord.

The histological changes are similar to those reported elsewhere by other workers; namely, perivascular infiltration of the central nervous system with lymphocytes, plasma cells and large mononuclear leucocytes, occasional capillary hæmorrhages, and rare nerve-cell degeneration.

An unusual skin lesion in ten cases is discussed. It passes through four stages—macular, papular, vesicular, and furfura-ceous—and is diagnostic when present.

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ILLUSTRATIONS

PLATE 1

- FIG. 1. Capillary hæmorrhage in III cranial nerve nucleus. Autopsy 9509.
2. Diffuse infiltration of the posterior cervical cord horn as well as the perivascular "mantle" of lymphocytes. Autopsy 9509.

PLATE 2

- FIG. 1. Large capillary, showing perivascular lymphocytic infiltration. Autopsy 9565.
2. High-power photomicrograph, showing the lymphocytic mantling of the venous capillaries. Autopsy 9565.

PLATE 3

Chinese mestizo, 17 years of age, showing diffuse distribution of the skin lesions in encephalomyelitis.

PLATE 4

Near view of the case illustrated on Plate 3, showing the vesicles on the posterior surface of the right shoulder.

PLATE 5

Filipino, 18 years old, posterior view, showing the late desquamating furfuraceous stage with the typical shoulder distribution of the lesions in encephalomyelitis.

TEXT FIGURE

- FIG. 1. Chart showing morbidity and mortality of epidemic encephalitis, Manila, 1922 and 1923.

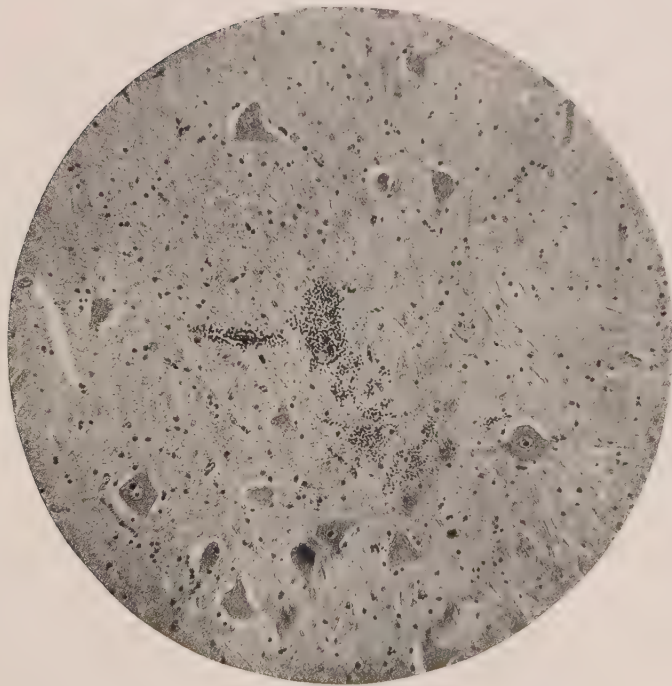


Fig. 1. Capillary hæmorrhage in III cranial nerve nucleus.

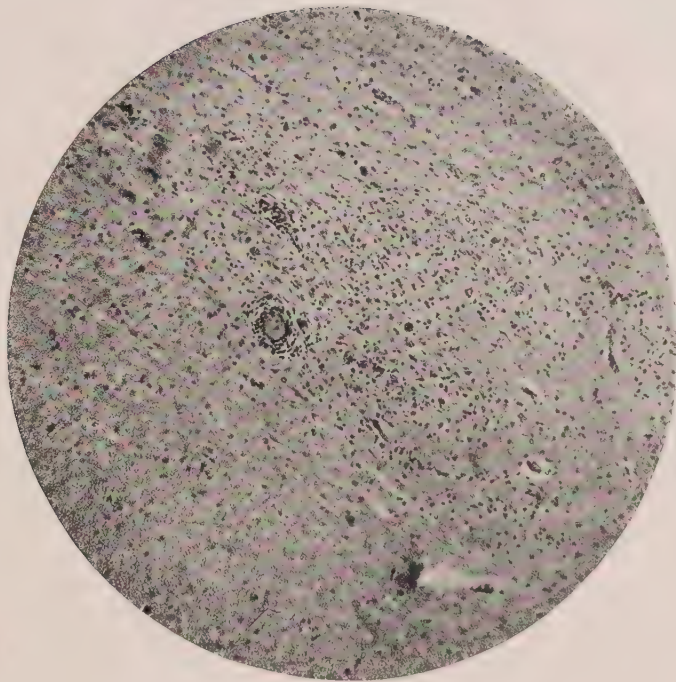


Fig. 2. Diffuse infiltration of the posterior cervical cord horn as well as the perivascular "mantle" of lymphocytes.

PLATE 1.



Fig. 1. Large capillary, showing perivascular lymphocytic infiltration.

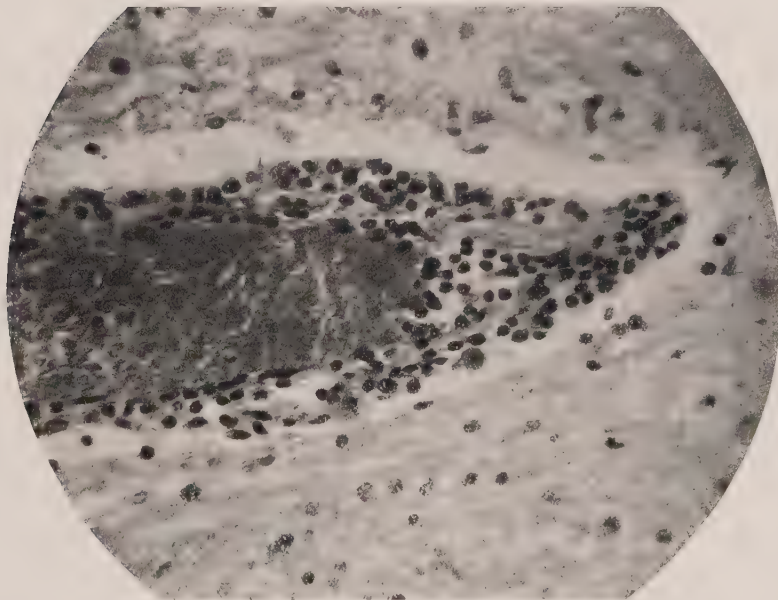


Fig. 2. High-power photomicrograph, showing the lymphocytic mantling of the venous capillaries.

PLATE 2.



Chinese mestizo, 17 years of age, showing diffuse distribution of the skin lesions in encephalomyelitis.

PLATE 3.



Near view of the case illustrated on Plate 3, showing the vesicles on the posterior surface of the right shoulder.

PLATE 4.



Filipino, 18 years old, posterior view showing the late desquamating furfuraceous stage with the typical shoulder distribution of the lesions in encephalomyelitis.

PLATE 5.

CHEMOTHERAPEUTIC EXPERIMENTS WITH CHAULMOOGRA AND ALLIED PREPARATIONS

II. COMPARISON OF THE ANTISEPTIC POWER OF CHAULMOOGRA OIL WITH THAT OF OTHER VEGETABLE AND ANIMAL OILS, RARE AND COMMON

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Having obtained the desired information from preceding experiments as to the growth-inhibiting activity of chaulmoogra and related oils, and having by a different method arrived at the same conclusions as did Walker and Sweeney, I have attempted to survey as many vegetable oils, both common and rare, as were available, to see if any of them exert action similar to that of chaulmoogra; namely, a specific inhibition of the growth of acid-fast bacilli.

Certain oils of animal origin have been included, for the reason that they are similar in a way to cod-liver oil which, as is known, has been both recommended and in use in the treatment of tuberculosis and leprosy. A certain amount of information as to the origin and composition was necessary, for the collection contains some little-known oils. We were fortunate in securing the coöperation of the botanists and chemists of the University of the Philippines and of the Bureau of Science, who supplied us with the necessary data and with samples of the oils.

The technic followed in these tests was the same as the one described in the previous paper.² The same culture of *Bacillus tuberculosis* and the same medium, glycerine meat infusion agar, were used as before.

The growth was recorded in two and again in four weeks after planting in the case of *Bacillus tuberculosis*, and after forty-eight hours' incubation in the case of *B. typhosus*, *Vibrio cholerae*, and *Staphylococcus*. With the last-mentioned cultures only one dilution of the oils was made (0.5 per cent) and only complete inhibition of growth was considered. It should be em-

¹ Member, Philippine Leprosy Research Board.

² Philip. Journ. Sci. 23 (1923) 533 to 542.

TABLE 1.—Showing results of experiments with various oils.

[+, growth as good as control; —, no growth in forty-eight hours; 0, not tested; /0. 1, less than 0.1 cubic centimeter; /1, less than one.]

| Name of oil. | Scientific name of source. | Growth on agar containing 0.5 per cent of oil. | | | | Bacillus tuberculosis growth inhibiting. |
|------------------------|--------------------------------|--|----------------------------|-------------------------|--------|--|
| | | <i>Vibrio cholerae</i> . | <i>Bacillus typhosus</i> . | <i>Staphylococcus</i> . | Titer. | Value. |
| Chaunmoogra, India | <i>Taraktogenos kurzii</i> | + | + | + | 0.005 | 20 |
| Hydnocarpus wightiana | <i>Hydnocarpus wightiana</i> | + | + | + | 0.001 | 100 |
| Hydnocarpus venenata | <i>Hydnocarpus venenata</i> | + | + | + | 0.005 | 20 |
| Hydnocarpus subfalcata | <i>Hydnocarpus subfalcata</i> | + | + | + | 0.005 | 20 |
| Hydnocarpus alcala | <i>Hydnocarpus alcala</i> | + | + | + | 0.005 | 20 |
| Cashew | <i>Anacardium occidentale</i> | + | + | + | 0.01 | 10 |
| Citri microcarpus | <i>Citrus microcarpus</i> | + | + | + | 0.05 | 2 |
| Pinnae sylvestris | <i>Pinus sylvestris</i> | + | + | + | 0.05 | 2 |
| Vetiver | <i>Andropogon zezanioides</i> | + | + | + | 0.01 | 10 |
| Caryophylli | <i>Eugenia caryophyllata</i> | — | — | — | 0.05 | 2 |
| Dacrydii | <i>Dacrydium</i> | — | + | + | 0.01 | 10 |
| Pittosporum | <i>Pittosporum resiniferum</i> | — | + | + | 0.05 | 2 |
| Cinnamon | <i>Cinnamomum zeylanicum</i> | — | — | — | 0.001 | 100 |
| Bergamot | <i>Citrus bergamia</i> | — | — | — | 0.01 | 10 |
| Eucalyptol | <i>Eucalyptus globulus</i> | + | + | + | 0.05 | 2 |
| Avocado | <i>Persea americana</i> | + | + | + | 0.05 | 2 |
| Bagilumbang | <i>Aleurites trisperma</i> | 0 | 0 | 0 | /0.1 | /1 |
| Betis | <i>Nadhua betes</i> | 0 | 0 | 0 | 0.1 | 1 |
| Bayabac lard | <i>Varanus spp.</i> | 0 | 0 | 0 | /0.1 | /1 |
| Calamus | <i>Acorus calamus</i> | 0 | 0 | 0 | /0.1 | /1 |
| Cedar | <i>Cedrela</i> | 0 | 0 | 0 | /0.1 | /1 |
| Ceara rubber | <i>Manihot glaziovii</i> | + | + | + | 0.1 | 1 |
| Coconut | <i>Cocos nucifera</i> | 0 | 0 | 0 | 0.1 | 1 |
| Cod liver | <i>Gadus callarias</i> | + | + | + | 0.1 | 1 |
| Corn, maize | <i>Zea mays</i> | 0 | 0 | 0 | /0.1 | /1 |

phasized that in these experiments glycerine meat infusion agar has been used as the culture medium to which the oils were added.

The bacteria other than *B. tuberculosis* were included in the test for the purpose of determining specificity or selective inhibitory power toward acid-fast bacilli in the case of a given oil which inhibited the growth of *B. tuberculosis* in at least as high a concentration as 0.5 per cent.

The collection contains forty-two different oils, including vegetable oils, essential oils, and animal oils, most of them found in the Tropics and also in the Philippines. The names, some of them local, indicate the source from which the oil is obtained. Scientific names of the plants and animals which yield the various oils are given in a separate column. They are arranged alphabetically in groups according to their growth-inhibiting effect, not as to their systematic or composition relationship. The figures given as growth-inhibiting titer indicate the amount of oil which, when added to 10 cubic centimeters of agar, still produced inhibition of growth of the culture; while the figures given as growth-inhibiting value express the relative strength of the inhibitory effect, 1 per cent concentration being taken as a unit.

It is evident from the results of the experiments shown in Table 1 that the oils investigated thus far can be classed into three groups, from the biologic standpoint. The first group contains oils which inhibit the growth on glycerine agar of acid-fast bacteria in comparatively small doses. This group can be subdivided into two; that is, oils which inhibit *B. tuberculosis* only and are indifferent as far as the growth of non-acid-fast bacteria is concerned and oils which inhibit the growth of *B. tuberculosis* and that of non-acid-fast bacteria.

The second group comprises oils which are indifferent as far as the growth of *B. tuberculosis* on glycerine agar is concerned; that is, when added to the culture media in small quantities such as were used in these experiments (1 per cent concentration), they do not influence the growth of acid-fast bacteria to any appreciable extent.

The third group consists of a few oils which, unlike those in the first group, seem to stimulate the growth on glycerine agar of *B. tuberculosis* in the concentration used rather than to inhibit it. That is to say, the growth appears more luxuriant and, in some cases, becomes perceptible sooner than in the control culture tubes containing glycerine and olive oil or glycerine only.

CONCLUSIONS

1. Certain vegetable oils, other than those containing the optically active fatty acids, inhibit the growth of acid-fast bacteria in vitro.

2. None of the vegetable oils proper that were investigated inhibit the growth of acid-fast bacteria to such a high dilution as do the chaulmoogra and *Hydnocarpus* oils which contain the optically active fatty acids.

3. Certain essential oils and oils containing volatile constituents show a very high selective inhibitory action upon acid-fast bacilli.



ACCESSORY LUNG, REPORT OF A CASE ¹

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THREE PLATES

Accessory lungs occur so very rarely that it is deemed desirable to report the instance that occurred in the Philippine General Hospital, if for no other reason than to record the fact. This case was encountered in the course of a routine autopsy; it is the first to have been seen among the more than 9,700 autopsies that have been performed in the College of Medicine and Surgery, University of the Philippines. Cunningham,² commenting on the anomalies of the lungs, says that very few cases of accessory lungs have been found. The most recent report referred to in the scanty literature available here seems to be that of Cockayne and Gladstone³ who found an accessory lung associated with hernia through a congenital defect of the diaphragm.

The commonest anomaly of the lung is abnormal or imperfect lobation, in either one or both lungs. Accessory lobes are also not infrequently found. Such findings as the presence of three lobes in the left lung, and two, or four, or more lobes in the right, are relatively common. An interesting anomaly in man is an occasional fourth lobe of the right lung, due to a rather deep indentation in the mediastinal surface caused by anomalies of the azygos vein, the so-called "lobulus Wrisbergi," or by the eparterial bronchial ramus arising directly from the trachea instead of from the main bronchus. This condition is normal in some of the lower animals, such as oxen and sheep.⁴

The case to be presented does not come under this category. There was present in the right pleural cavity a completely inde-

¹ Read before the Culion Medical Society, June 29, 1923. Observations made in the department of Pathology and Bacteriology, College of Medicine and Surgery, University of the Philippines.

² Textbook of Anatomy. Wm. Wood & Co., New York (1921) 1098.

³ Journ. Anat. London 52 (1917) 64-96.

⁴ Bailey and Miller, Textbook of Embryology. Wm. Wood & Co., New York (1911) 370.

pendent, functionless, accessory mass of pulmonary tissue. Both lungs were, anatomically speaking, normal in every respect.

The patient, J. M., a female Filipino infant, 5 months of age, was admitted to the surgical wards of the Philippine General Hospital on January 22, 1921, and died ten days later. The clinical diagnosis was acute cellulitis of the face, with septicæmia. There was nothing of importance in the history except that the mother was an inmate of the insane department of the San Lazaro Hospital.

Necropsy was performed eighteen hours post mortem.

The body was that of a small female Filipino child, 60 centimeters in length and 3.13 kilograms in weight. Development was rather poor, and nourishment was extremely poor. No anatomical abnormality could be found on careful external examination. The scalp was œdematous, and the superficial lymph nodes were rather prominent and palpable.

The subcutaneous tissue of the thorax and abdomen was œdematous and infiltrated, and a few pockets of pus were found.

The contents of the abdominal cavity showed nothing of interest. The organs were in a normal relation and none except the kidneys presented any gross pathological changes; these showed evidences of an acute parenchymatous nephritis. The heart and brain were normal.

In the superior mediastinum there were three fairly large, deeply congested, juicy lymph nodes, from the deep red cut surface of which blood exuded.

The lungs were normal in lobulation, but both showed bronchopneumonic changes.

Lying free in the right pleural cavity (Plate 1), resting on the posterior thoracic wall between the level of the sixth interspace and the eleventh rib, was a roughly oval mass that was deep red, firm in consistency, noncrepitant, with much the appearance of spleen tissue. This mass was 5.2 centimeters long, 3.1 centimeters wide, and 1.4 centimeters thick at its middle portion. Its lateral edge was smooth and thin, while the medial edge was thicker and had a slight indentation, a hilus through which the blood vessels and nerves entered. The superior pole was slightly less rounded than the inferior pole. The surface was slightly irregular, particularly posteriorly. The capsule was rather thick and showed fairly large blood vessels. The mass received its blood supply directly from the aorta by a relatively large branch, 1.6 centimeters in length and 0.6 centimeter in width, which sprang at right angles from that vessel

at the level of the ninth dorsal vertebra. The vein from the mass emptied into the vena azygos at a slightly higher level. The nerve supply was traced from the sympathetic trunk at the sixth thoracic ganglion.

On section, macroscopically this organ showed a deep red glistening meaty surface with fairly large circular blood vessels from which a considerable amount of blood exuded on pressure. Pieces of the tissues failed to float on water.

Microscopically the organ was found to be practically identical structurally with an atelectatic lung of a new-born child (Plates 2 and 3). Bronchioles are present in large numbers, but they are without apparent order or arrangement; on the whole, they are strikingly large, as compared to the amount of alveolar tissue present. Fairly large ones are found close to the pleural covering, although the largest are near the hilum. In sections taken near the hilum the bronchioles are lined with ciliated pseudostratified columnar epithelium, resting on a distinct tunica propria. The band of circular muscle fibers is also present, although this is thinner and looser than in a normal lung. A few small, ill-developed mucous glands are present, but no cartilage can be found. The smaller bronchioles, in sections taken from the periphery of the organ, as in a normal lung, are devoid of glands and are lined with ciliated columnar epithelium. In many this is distinctly hyperplastic, so that the lumen is practically obliterated by the closely packed folds of mucosa. This shows signs of activity in the presence of a few goblet cells and a little coagulated albuminous material in the lumen.

The alveoli are for the most part small and completely collapsed. Those that are patent are very irregular in shape, and most contain a few desquamated epithelial cells. The alveolar walls are thick, some with an unusual amount of young connective tissue, and contain mononuclear wandering cells. The capillaries are dilated and engorged with erythrocytes. Proportionately enormous blood vessels with well-organized walls are seen in all the sections.

The pleural covering is thick, the layer of flat mesothelial cells resting upon a thick layer of young connective tissue that is continuous with the interlobular septa. This also carries blood vessels.

The large deep red glands in the mediastinum are found to have the histological characteristics of hæmolymp nodes.

COMMENT

We know that in its embryological development the lung begins as a median ventral longitudinal groove in the cephalic end of the foregut. This later becomes constricted in its posterior portion and grows caudally, becoming differentiated into the bronchi and lung buds. From the very beginning the right lung bud shows three different lobulations, while that of the left shows only two. This occurs with great regularity in man.

These early lobulations are maintained throughout the embryological period and determine the lung lobes. These structures continue growing in size and complexity until they are completely formed into the structure of the fully developed lung. Accessory lobes may be formed by further branching of the stem bronchus in the pulmonary wings, or by evagination from the original anlage, or as separate anlagen from the foregut.

In the present case it seems probable that, though it had completely separated from its point of origin, this accessory lung mass developed as a separate anlage. Had it been but an evagination of the pulmonary wing that was later constricted off, it seems likely that it would have been more closely related to, or would have retained some connection with, the lungs or bronchi, whereas it has absolutely no traceable communication with either. Furthermore, its blood supply would have come from the pulmonary artery, from an intercostal artery, or at least from high in the upper portion of the aorta as the bronchial arteries normally do. Actually, the pulmonary artery sends no branch into this mass and its blood is supplied by a short, disproportionately large vessel that arises directly from the aorta nearly as far back as the diaphragm. Its blood empties into the azygos vein. Its nerve supply comes from the right sympathetic trunk at the sixth thoracic ganglion. Therefore, it shows no arterial, venous, or nervous connection with the right lung which, except for a slight modification of shape incidental to the presence of the accessory mass in the same pleural cavity, was anatomically normal.

I wish to express appreciation for courtesies extended by Dr. H. W. Wade, chief pathologist of Cullion Leper Colony, in connection with the preparation of this report.

ILLUSTRATIONS

PLATE 1

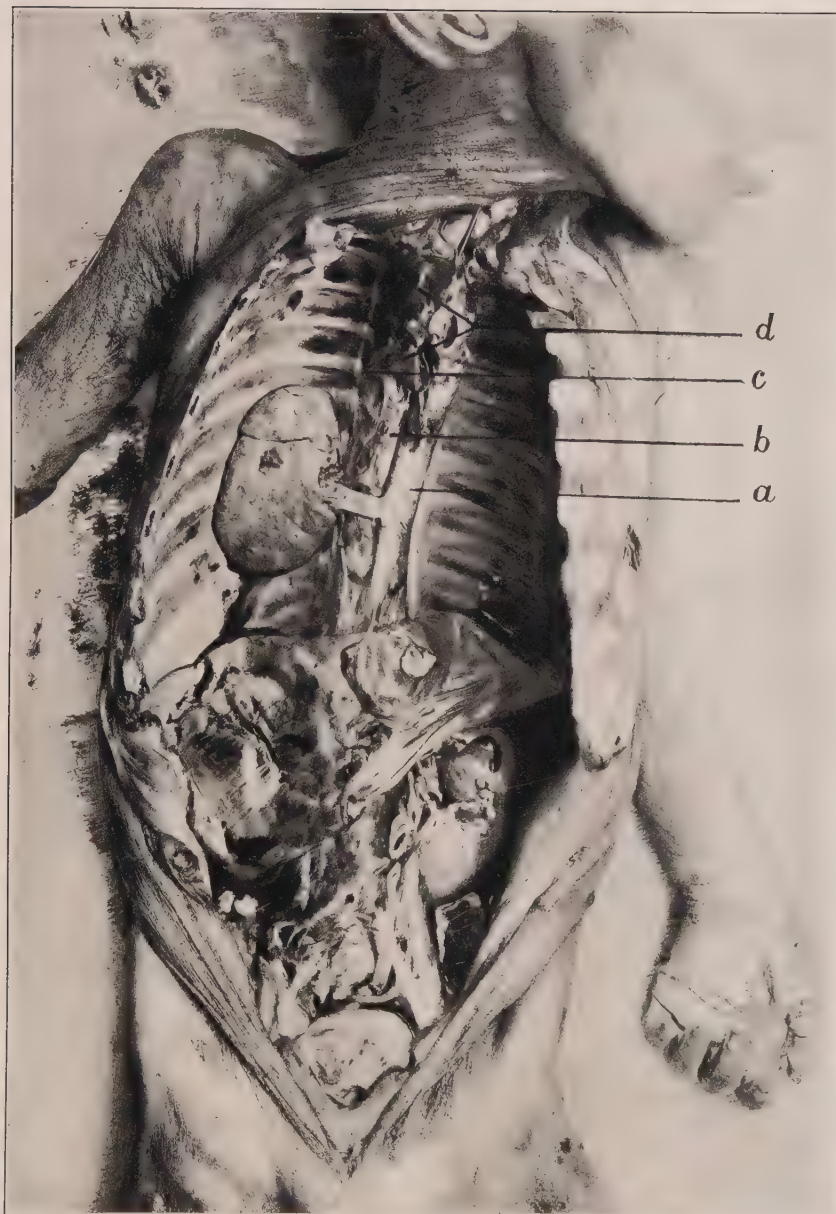
Body of child, showing the accessory pulmonary mass. *a*, aorta; *b*, azygos vein; *c*, sympathetic trunk; *d*, hæmolymp nodes.

PLATE 2

Section of the accessory pulmonary mass, showing a thick pleura, alveoli, alveolar walls, bronchioles, and blood vessels.

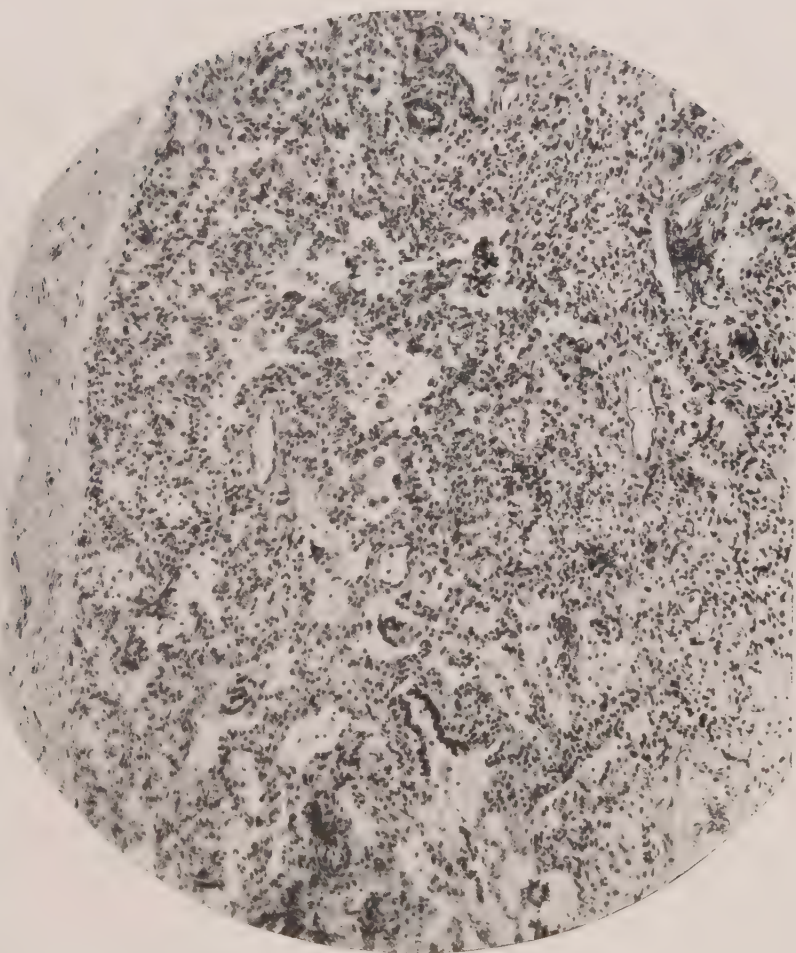
PLATE 3

Section of the accessory pulmonary mass, showing distinctly desquamated epithelial cells inside the alveoli; alveolar walls and engorged blood vessels.



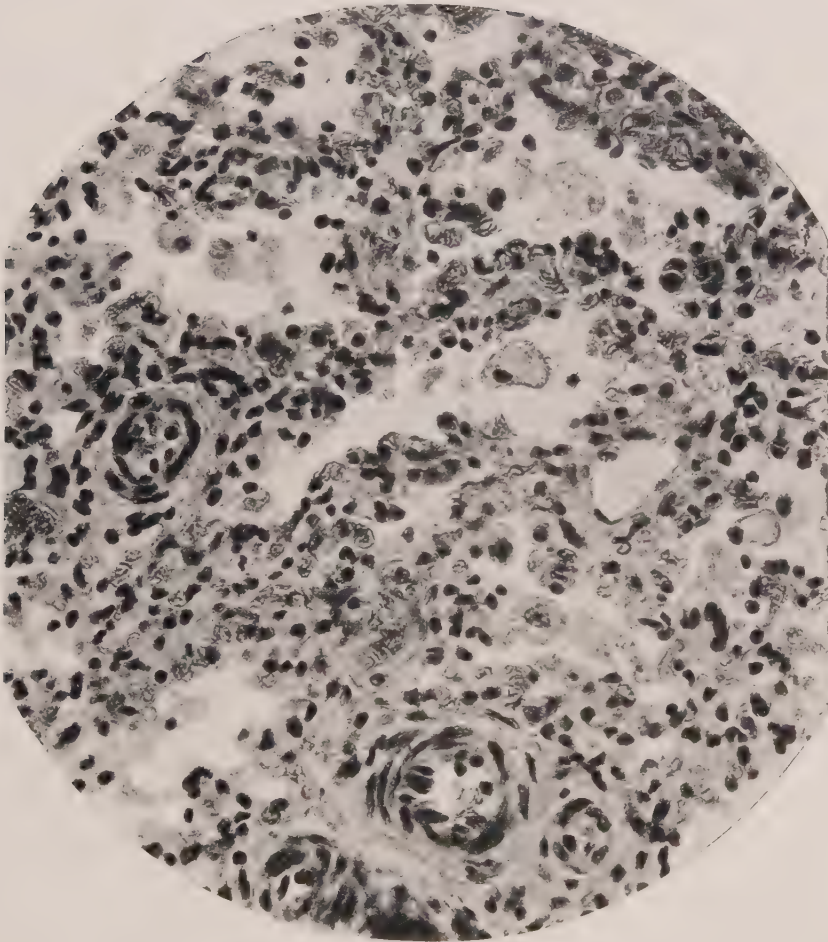
Body of child, showing the accessory pulmonary mass. *a*, aorta; *b*, azygos vein; *c*, sympathetic trunk; *d*, hæmolymph nodes.

PLATE 1.



Section of the accessory pulmonary mass, showing a thick pleura, alveoli, alveolar walls, bronchioles, and blood vessels.

PLATE 2.



Section of the accessory pulmonary mass, showing distinctly desquamated epithelial cells inside the alveoli; alveolar walls and engorged blood vessels.

PLATE 3.

THE VIABILITY OF INTESTINAL PATHOGENIC
BACTERIA IN FRUITS AND PHILIPPINE
FOODS EATEN RAW ¹

By ANA VASQUEZ-COLET

Of the Bureau of Science, Manila

Fruits and other articles of food eaten raw have often been blamed as being carriers of infectious material, and for this reason their sale in the public markets of Manila has in times of epidemic been forbidden. The purpose of the experiments here reported was to test the viability of three of the most important intestinal pathogens (*Vibrio cholerae*, *Bacillus dysenteriae*, and *Bacillus typhosus*) in fruits and other articles of food eaten raw, especially by Filipinos, to determine what rôle they play in the spread of epidemics.

Consultation of the literature shows that a few experiments similar to these were undertaken by M. A. Barber ² in connection with an experiment on cockroaches. He says:

The longevity of cholera vibrios in cockroach faeces after discharge from the insect is probably short when the faeces are deposited in places where they can readily dry, but when discharged on moist food vibrios may remain for some time. To test this matter, some fresh cockroach faeces were placed on four different kinds of food: fresh beef, lettuce, fish, and clams. In every case, the cholera vibrios remained viable for at least sixteen hours at room temperature.

In this connection it may be worth while to mention the results obtained by me in some recent experiments on the longevity of cholera vibrios in human faeces placed on various foods in use in this locality. Here, as in the case of the experiments with cockroach faeces, the cholera vibrios must compete with the other bacteria present in the faeces and with the microorganisms already present in the food. On the cut surfaces of a cucumber, a chico, and a papaya fruit—all distinctly acid to litmus—and on the leaves of lettuce, the cholera vibrios survived overnight in one experiment. In another test, cholera vibrios in human faeces survived twenty hours on the cut surfaces of cucumber and papaya fruits, but failed to live forty-four hours. On two varieties of shrimp, cholera vibrios in human faeces remained viable twenty-two hours; on oysters, forty-six hours; and

¹ Read before the 19th Annual Meeting of the Philippine Islands Medical Association, December 21, 1922.

² Philip. Journ. Sci. § B 9 (1914) 1-4.

on the inside of an opened clam, four days. In all of these four foods, other bacteria were very numerous; in the oysters, especially, they were so plentiful that the food was acid in reaction when the cholera vibrios were placed on it. It is probably fair to assume that cholera vibrios, when abundant in cockroach faeces, would survive as long on foods as when in human faeces.

Filipinos are very fond of eating certain fruits and foodstuffs in a raw condition. Two such very favorite foodstuffs are *bagong* and *patis*. Bagong consists of very small shrimps pickled with salt. Patis is obtained from bagong by extraction and boiling. It is a dark brown salty liquid with a characteristic odor. The people obtain these two foodstuffs, already prepared, in the open market (where it is kept in open vessels, and handled freely without any particular regard to asepsis) and eat them without cooking. Certain dishes are more palatable when eaten in conjunction with bagong and patis. Certain cooked vegetables are nice to eat with bagong, while fish and meat are more palatable when dipped in patis. Native vinegar is a whitish, sour liquid, obtained by a process of fermentation from the nipa palm.

Presumptive tests and colony counts for bagong, patis, and native vinegar showed them to be negative for *Bacillus coli*, but very rich in bacteria. Bagong gave 100,000 colonies per gram; patis gave an innumerable bacterial count; vinegar had 34,000 bacteria per cubic centimeter; these were mostly yeast colonies.

The material used in my experiments consisted of fresh ripe fruits, bagong, patis, and native vinegar, obtained in the open market. The technic employed was simple. The fruits and the foods were distributed in wide-mouthed sterile bottles, one variety to a bottle. The reaction of the fruits to litmus was tested; they were all acid. Cultures of the given bacteria emulsified in sterile, distilled water were introduced into the bottles by means of a sterile pipette, or were smeared on the fruits by means of sterile swabs, according to the experiment. In a few of the experiments the bacterial emulsions were mixed with fresh, human faeces, but in the majority of them this was omitted.

Tests were made according to the usual routine procedures for the isolation of these bacteria: enrichment, plating, fishing, agglutinating, and sugar reactions. The procedure was as follows:

The fruits and other foodstuffs were distributed in wide-mouthed, sterile bottles; they were contaminated with emulsions

of the given bacteria prepared from eighteen- to twenty-four-hour-old cultures in agar. Some of the fruits were smeared over with the bacterial emulsions on the outside, others on the cut surface. In Table 1 the fruits contaminated on the outside are indicated by the word "outside," and those contaminated on the cut surface by the words "cut surface." From hour to hour and day to day (or every so many minutes, according to the experiment) transplants were made from the contaminated surfaces, and suspicious colonies examined for the corresponding bacteria.

The findings, as a whole, confirm the belief that fruits and other articles of food, eaten raw, may convey infection, but not to a marked extent, it would seem. It must be remembered that in these experiments the fruits and raw foods were heavily contaminated with pure bacterial emulsions, which does not happen under ordinary circumstances, and in spite of this the bacteria did not survive very long. It seems that the admixture of human faeces lessens the probabilities of survival for the cholera vibrio. In foods very rich in bacteria, like patis, the cholera vibrios cannot survive even one hour. The same is true of fermenting foodstuffs.

Experiments with the cholera vibrio show that it survives from four hours to one day, at least, in bagong; one hour in patis; in vinegar, at the end of one hour no cholera vibrio could be isolated. In native cheese (queso) the cholera vibrio will survive at least two hours. On the cut surface of mangoes, bananas, chicos, and lanzones the cholera vibrio survives at least one day; on the cut surface of guavas it survives at least five hours; on the cut surface of apples it seems to thrive well; at the end of six days the infected apples were still positive for cholera vibrio. On the outside of bananas the vibrio remains viable for at least two days; on the outside of lanzones, one day; and on the outside of apples, four days.

Similar experiments were performed with *Bacillus typhosus*. From bagong, contaminated with *B. typhosus*, the bacillus could not be isolated at the end of five minutes; in patis, it can survive at least one day; in vinegar, five minutes. In native cheese it is still viable at the end of two days. On the cut surface of mangoes, bananas, and guavas it survives at least one day; on that of chicos, two days; on the cut surface of lanzones, seven hours; on the cut surface of apples it remains viable for at least three days. On the outside of apples and lanzones, it survives seven hours; on that of bananas, six hours.

The viability of *Bacillus dysenteriae* (Flexner and Shiga) in such foodstuffs was also tested. Bagong, contaminated with a Flexner strain, is negative for dysentery bacilli at the end of five minutes. The same is true of bagong contaminated with a Shiga strain. In patis, the Flexner strain can survive two hours, while the Shiga strain cannot be found at the end of five minutes. In native cheese the Flexner strain survives at least five days, and the Shiga strain two days. On the cut surface of mangoes *B. dysenteriae* (Flexner) survives four hours; on that of bananas, one hour; on the cut surface of chicos, three hours. From the cut surface of lanzones no dysentery bacilli could be isolated at the end of one hour; on the surface of apples it survives for at least three days; on that of guavas, one day. On the outside of apples and lanzones it survives seven hours; on that of bananas, six hours. The Shiga strain seems not to thrive in these fruits. From both the cut surface and the outside of apples, bananas, guavas, and lanzones, contaminated with this strain, no bacilli could be isolated at the end of one hour.

The results obtained with the different bacteria are tabulated in Table 1. In this table the time recorded is the length of time after which the organism was not recovered.

TABLE 1.—Results of exposure of certain Philippine fruits and other foods to three important pathogens.

| | Cholera vibrio. | | Pure cultures. | | |
|-----------------------------|-----------------|-------------------|----------------------------|-------------------------------|------------|
| | Pure cultures. | Mixed with fæces. | <i>Bacillus typhosus</i> . | <i>Bacillus dysenteriae</i> . | |
| | | | | Flexner. | Shiga. |
| | Days. hrs. | Days. hrs. | Days. hrs. | Days. hrs. | Days. hrs. |
| Bagong..... | 2 | 5 | 1 | | |
| Patis..... | 2 | 1 | 2 | | |
| Vinegar..... | 1 | 1 | 1 | | |
| Mango (cut surface)..... | 2 | | 2 | 5 | 1 |
| Banana (cut surface)..... | 2 | 7 | 2 | 2 | 1 |
| Banana (outside)..... | 3 | 2 | 7 | 7 | 1 |
| Chico (cut surface)..... | 2 | 3 | 3 | 4 | 1 |
| Lanzones (cut surface)..... | 2 | | 1 | 1 | 1 |
| Lanzones (outside)..... | 2 | | 1 | 1 | 1 |
| Apple (cut surface)..... | 7 | 5 | 4 | 4 | 1 |
| Apple (outside)..... | 5 | 2 | 1 | 1 | 1 |
| Queso..... | 3 | | 3 | 6 | 3 |
| Guava (cut surface)..... | | | 2 | 2 | 1 |
| Guava (outside)..... | | | | | 1 |
| Chico (outside)..... | | 7 | | | |

CONCLUSIONS

The cholera vibrio will survive on human food from a few hours to at least six days; when mixed with human fæces, its probabilities of survival seem to be much lessened.

The typhoid bacillus on human food will survive from a few minutes to at least three days.

The dysentery bacilli (Flexner and Shiga types) survive on human food from a few minutes to at least five days.

LARYNGEAL SYMPTOMS IN BERIBERI¹

By ANTONIO S. FERNANDO

Of the Philippine General Hospital, Manila

Beriberi, a tropical disease, characterized by a multiple neuritis, the result of a certain kind of vitamine-deficient nutrition, occasionally gives rise to symptoms referable to the eyes or to the throat. The eye symptoms have been extensively studied in Japan, and in an article published by me in 1923² I attempted to give an account of my meager observations on the same symptoms as observed in the Philippine Islands. Laryngeal symptoms in the form of hoarseness and even aphonia have been observed in beriberi patients, in both infants and adults. In infants, aphonia has been observed so frequently that it is considered one of the most characteristic symptoms of infantile beriberi. It is observed especially in the later stage of the disease. In adults it is not so frequent as in children, although it does occur occasionally. Vedder, in speaking of this symptom in beriberi, says: "Aphonia is a peculiar symptom that requires mention for it occurs with some frequency in chronic cases. The speaking voice is lost and the patient can only whisper." It was described as early as 1642 by Bontius who said, "while suffering from this disease the sound of my voice was so feeble for a whole month that those sitting next to me could not understand me."

Both of the cases that came to my observation in the Philippine General Hospital were of the cardiac type of beriberi, with complaints of hoarseness. This was found to be due to vocal cord paralysis.

Case 1, B. R., male, Filipino, 19 years old, had been confined to the medical ward of the hospital because of beriberi of the cardiac type. After a month or so he was discharged improved, but the hoarseness that developed persisted. He then came to me in the eye, ear, nose, and throat clinic of the free dispensary of the hospital. Laryngoscopic examination showed complete paralysis of the left vocal cord. Other laryngeal structures

¹ Received for publication August 24, 1923.

² See Elliot's Tropical Ophthalmology, Am. Journ. Ophthal. 6 (1923).

appeared normal. X-ray of the chest was requested for discovery of possible aneurism of the aorta or of mediastinal tumor, but the roentgenologist reported as follows: "No changes of aneurism. General enlargement of the heart." In this connection it may be of interest to state here that in this hospital we very rarely observe aneurism of the aorta.

Case 2, C. P., female, 18 years old, admitted to the hospital because of acute beriberi, cardiac type, and acute cholecystitis; also referred to me by Dr. A. B. M. Sison because of the complaint of hoarseness. Examination showed total immobility of the left vocal cord. The other laryngeal structures were apparently in normal condition. X-ray of the chest showed enlargement of the heart.

In both cases the left vocal cord was the one paralyzed. It assumed the cadaveric position, remaining immobile during phonation, while the right cord came to the middle line and even a little beyond this. No changes of any importance were found in the other laryngeal structures.

Last year I saw a patient in the dispensary who complained of foggy vision. At that time, he was still being treated in the medical clinic for beriberi. He gave a history of having had hoarseness while suffering from numbness of the legs and dyspnea on slight exertion. He said he had been under antiberiberi treatment for some time and that his voice improved with the improvement of the other symptoms of the disease. Could not the laryngeal symptom in this case be secondary to the general disease from which the patient was suffering?

Now, among infants in whom hoarseness and aphonia have been more constantly observed, I have not attempted any laryngoscopic examination to determine the lesion in the larynx, especially in the cords.

As to the cause of the vocal-cord paralysis in these cases I have nothing definite to offer. In reviewing several textbooks of laryngology I have not been able to find any reference regarding vocal-cord paralysis in connection with beriberi. To laryngologists in the Tropics, especially in this country where the disease is endemic, the recognition of such a condition is very important. It has been found that pressure on the recurrent laryngeal nerve by aneurism, by mediastinal tumors, and even by an enlarged heart (according to some) may give rise to paralysis of the vocal cords. In the cases here presented the first two conditions are ruled out by the X-ray examinations.

It appears from the records in the Philippine General Hospital that the fulminant type of the disease (which is almost always fatal, many patients lasting only a few hours) rarely gave rise to any form of laryngeal symptom. The heart enlargement in these cases is very marked, and if we presume that the paralysis of the vocal cords in beriberi is due to pressure by the enlarged heart it is but reasonable to expect more of these cases of hoarseness in this type of the disease.

In infantile beriberi the loss of voice is complete, and in such cases most probably both cords are paralyzed. This condition can hardly be brought about by pressure from an enlarged heart because of the higher position of the right laryngeal nerve. Vedder, an authority on beriberi, believes that the aphonia in this disease is "probably due to degeneration of the pneumogastric nerves thus causing paralysis of the laryngeal muscles." As beriberi is a condition characterized by multiple neuritis, I am also inclined to believe, with Vedder, that this laryngeal symptom may be secondary to changes in the nerve supplying the laryngeal muscles, such changes (degenerative) being similar to those observed in the other nerves. Further clinical observations of this symptom in beriberi, together with post-mortem microscopical study of the laryngeal nerves in those with symptom of hoarseness or of aphonia who have died, should be made, as it is only by this means that the question can be settled definitely.

NEW BUPRESTID BEETLES FROM THE PHILIPPINE ISLANDS, I

By W. S. FISHER

Of the Bureau of Entomology, United States Department of Agriculture

In working over a collection of buprestid beetles collected on Sibuyan Island by Prof. Charles Fuller Baker, College of Agriculture, University of the Philippines, Los Baños, P. I., a few new species have been found; these are described in the present paper.

Through the kindness of Professor Baker, the types of the new species have been placed in the collection of the United States National Museum.

Chrysodema sibuyanica sp. nov.

Form oblong-oval, attenuate in front and more acuminate behind, moderately convex; when viewed in profile, ventral surface is nearly straight to apical third, then strongly arcuately attenuate to apex, and dorsal surface feebly arcuately rounded; head and scutellum cupreous; pronotum greenish blue, the reliefs cyaneous with a strong violaceous tinge, lateral margins narrowly æneous posteriorly; elytra æneo-brunneous, the reliefs bluish black; abdomen beneath bluish green, with a strong violaceous tinge, the segments transversely cupreous along base, giving them a banded appearance; balance of body beneath æneo-viridis, with a strong violaceous tinge, becoming cupreous toward sides; legs bluish green, with a strong violaceous tinge.

Head nearly flat, with a deep concave impression on front and vertex, the concavity extending to margin of eyes, and with a longitudinal groove extending entire length, the groove rather deep on front, but becoming only feebly impressed on occiput; surface with two irregular ridges behind antennal cavities and rather densely punctate, the punctures deep and well separated on occiput, becoming finer and more inconspicuous in the concave area, sparsely clothed with fine, erect, cinereous hairs; epistoma broadly arcuately emarginate in front. Pronotum moderately convex, slightly more than one and one-half times as wide as long, narrower in front than behind, widest at base;

marginal carina not attaining apex; sides feebly arcuately narrowed from base to apex; anterior margin arcuately emarginate, with a broadly rounded median lobe; base feebly sinuate; surface somewhat rugose toward sides, with a feeble elongate impression extending from near base at middle of elytron obliquely to lateral margin near middle and replacing the usual deep fovea, and with a broad smooth median carina extending from base to anterior margin, deeply, coarsely punctate, the punctures very irregularly distributed, causing numerous irregular reliefs, which are shining; very finely punctured, and densely obsoletely granulose; surface also very sparsely clothed with short inconspicuous hairs. Scutellum wider than long, trapezoidal in form, widest at base; surface nearly smooth, with a small fovea at middle. Elytra rather strongly convex, without basal impressions, slightly wider than pronotum at base; sides feebly arcuate from base to near middle, where they are slightly sinuate, then arcuately attenuate to the tips, which are rather acute and armed with five strong, acute teeth, sides also more or less irregularly serrate near the middle; humeral angles broadly rounded; each elytron with four distinct broad costæ, not including the sutural elevation, which is feebly longitudinally divided behind scutellum; first costa entire, extending from base to apex and parallel to suture; second one feebly sinuate and extending from base to near apex, where it is connected to the first; third extending from near humeral angle to apical fourth and parallel to marginal costa; and a marginal one extending from humeral angle to apex and parallel with lateral margin; there is also indication of a short costa at base between second and third costæ; all of the costæ are about an equal distance apart, smooth, and with a few large punctures irregularly distributed; intercostal spaces rather densely punctate, the punctures large and irregularly placed, surface also very sparsely clothed with extremely short inconspicuous hairs, and somewhat transversely rugose behind the humeri, which are not prominent. Abdominal segments with a few large punctures on apical half, but densely and finely punctured along basal parts, where the surface is also rather densely clothed with very fine recumbent hairs; last segment strongly acuminate at apex, with a deep oval emargination at tip; there is also a shallow longitudinal impression extending from apical emargination to about middle of segment, where the surface is more finely and densely punctured, and with a dense bunch of long yellowish pubescence, which nearly conceals the emargi-

nation; balance of body beneath deeply and irregularly punctate, the punctures coarse and widely separated at middle, but becoming finer and denser at sides, where the pubescence is similar to that of the basal portions of abdominal segments; tarsi violaceous.

Length, 30 millimeters; width, 10.

Type locality.—Sibuyan Island, Philippines.

Type and paratype.—Catalogue No. 25949, United States National Museum.

Described from two specimens collected by Prof. C. F. Baker on Sibuyan Island (*Baker 18974*). The paratype is smaller than the type, measuring only 24 millimeters in length and 8 millimeters in width, and only differs from the type in a few small details, namely: The elytral costæ are of a more bluish green color, the elytra has the apex not as strongly toothed and the sides not serrate, and the apical emargination of the last abdominal segment is slightly smaller and not as deeply emarginate.

This species is very closely allied to *Chrysodema eximia* Castelnau and Gory in sculpture and outline, but can be easily distinguished from that species by the coloration.

Chrysobothris sibuyana sp. nov.

Female.—Form moderately convex, head cupreous, pronotum reddish cupreous, with the anterior edge narrowly margined with bright green, scutellum dark green, elytra purplish brown, becoming more bluish on disk; each elytron ornated with bright green spots as follows: A large area starting at basal impression, then covering humeral region and extending along side to near middle and terminating in a large round green fovea on disk just in front of middle; two small round green foveæ at apical fourth, which are placed transversely on disk and connected to each other on inner margin; sutural margin posteriorly and apex with a slight greenish tinge. Body beneath bright shining green with sides purplish cupreous and posterior margin of abdominal segments narrowly margined with blue; legs purplish cupreous, with base and dorsal side of femora greenish; tarsi cyaneous.

Head with front strongly triangular and surface sparsely clothed with a few inconspicuous cinereous hairs; occiput very narrow, longitudinally carinate, and surface irregularly, coarsely, and rather deeply punctate, the punctures becoming confluent along eyes; vertex with a broad transverse obtuse ridge, which

does not protrude over front, nor extend to lateral margins; front broadly but not very deeply concave, the concavity somewhat irregularly concentrically striolate, the striæ widely separated and the intervals nearly smooth, with a few small, irregularly placed punctures, sides very coarsely and confluent punctate; eyes large and nearly contiguous on occiput; epistoma large, broadly and deeply arcuately emarginate in front; antennæ purplish cupreous, with the second joint slightly aureous. Pronotum strongly transverse, and moderately convex, twice as wide as long, front and base about equal in width; sides nearly parallel and bisinuate (obliquely expanded from anterior angles to apical sixth, then feebly arcuately emarginate to basal sixth, and finally obliquely narrowed to posterior angles, which are broadly obtuse); anterior margin with an obscurely rounded median lobe; base very deeply bisinuate, with a large broadly rounded median lobe, which is truncate in front of scutellum; surface without impressions, strongly, densely, and transversely rugose, the rugæ becoming more irregular toward sides, intervals sparsely irregularly punctate, the punctures becoming coarser and denser along lateral margins. Scutellum small, triangular, with the three sides about equal in length, and the surface obsoletely granulose. Elytra distinctly wider than pronotum at base, rounded at humeral angles and nearly parallel to apical third, then arcuately attenuate to tips, which are broadly rounded; lateral margins coarsely and irregularly serrate, the teeth becoming nearly obsolete on anterior half; base strongly lobed; surface nearly smooth and rather densely punctate, the punctures widely separated on disk, but becoming denser and coarser at base, apex, in the impressed areas and along lateral margin, where the surface is also feebly rugose, the rugæ becoming more distinct in the humeral regions; each elytron with two broad obsolete costæ on apical half, one along suture and the other along lateral margin, the costæ not extending to middle of elytron; there are also a deep impression at middle of base, a shallower one near humeral angle, a large round one on disk near middle, and two smaller round ones, transversely placed on disk at apical fourth. Abdomen beneath coarsely punctate, the punctures widely separated on median part, the surface becoming finely, longitudinally striolate along lateral margins and clothed with a few inconspicuous hairs; last segment deeply, broadly arcuately emarginate at apex, with a short obtuse tooth at middle of emargination and a strongly elevated longitudinal carina extending from apex to about middle

of segment. Prosternum nearly flat, and very coarsely punctate, the punctures becoming transversely confluent on anterior part, the surface very sparsely clothed with long cinereous hairs. Femora robust, the anterior ones with a broad obtuse tooth on outer edge at apical third.

Length, 10.5 millimeters; width, 4.5.

Type locality.—Sibuyan Island, Philippines.

Type.—Catalogue No. 25947, United States National Museum.

Described from a single female from Sibuyan Island, collected by Prof. C. F. Baker.

This species is closely allied to *Chrysobothris pictiventris* Saunders, but is a much smaller species, the transverse carina on front of head is more obtuse, the pronotum more reddish cupreous and without the posterior angles aureous, and the base more deeply sinuate; elytra with the basal lobe more angulated, the green color on basal part more extended, the two spots at apical fourth connected and impressed, and the punctures more widely separated on the disk; the last abdominal segment more deeply emarginate at the apex, the median tooth not as long as the outer teeth, and the median carina extending to anterior margin of segment.

Philanthaxia cumingii var. *basalis* var. nov.

Oblong-oval, head and pronotum reddish cupreous, elytra reddish cupreous, becoming more brownish on disk and with basal third bluish green; surface above glabrous; beneath æneous and sparsely clothed with very short, recumbent, cinereous pubescence.

Head strongly convex, transversely concave between antennæ; surface strongly reticulate, the reticulation forming a network of small irregular sunken areas, in the center of which is a small puncture; eyes large, prominent, extending slightly beyond pronotum on each side; epistoma wide, truncate in front. Pronotum convex, nearly twice as wide as long, distinctly narrower in front than behind, widest at base; sides obliquely attenuate from base to apex; anterior margin arcuately emarginate, with a feebly rounded median lobe; base transversely truncate; surface with an obsolete broad impression on each side near posterior angles, reticulation similar to that on head but becoming finer on anterior part of disk and more transverse in front of scutellum. Scutellum cordiform, truncate in front, wider than long; surface finely reticulate and strongly impressed at middle. Elytra about equal in width to pronotum at base; sides strongly

expanded behind humeri, where they are distinctly wider than pronotum, nearly parallel to apical third, then obliquely attenuate to tips, which are separately, narrowly rounded; lateral margin finely serrate; base with a transverse impression, becoming deeper externally; humeri prominent; surface deeply and regularly striate, the striæ not quite reaching to apex, and becoming less distinct toward base; intervals flat, densely transversely rugose, rather densely finely punctate, and becoming finely scabrous at apex. Abdomen beneath densely and rather coarsely ocellate-punctate, becoming somewhat longitudinally rugose on last segment, which is broadly rounded at apex; posterior coxæ with posterior margin truncate; prosternum, mesosternum, and metasternum strongly and densely scabrous at middle; femora and tibiæ finely but not densely rugose.

Length, 7.2 millimeters; width, 3.25.

Type locality.—Sibuyan Island, Philippines.

Type.—Catalogue No. 25950, United States National Museum.

This variety is described from a single example from Sibuyan Island, collected by Prof. C. F. Baker. It differs from *Philanthaxia cumingii* Waterhouse in having the basal third of the elytra bluish green, and the eyes more projecting.

Cisseicoraebus bakeri sp. nov.

Form elongate, subcylindrical, broadly rounded in front and moderately attenuate behind; when viewed in profile the surface is nearly straight beneath and broadly arcuate above; golden green, with a slight cupreous tinge in certain lights. Each elytron narrowly margined with a cyaneous color and ornated with irregular cyaneous spots and fasciæ, these spots and fasciæ narrowly margined with a lighter shade of blue and arranged as follows: Three spots along suture, the first one a little behind scutellum, an oblong one near middle, and a smaller one at middle slightly in advance of the first transverse fascia; a broad transverse fascia just behind middle, extending from lateral margin to middle of disk and connected to a very narrow oblique band, which extends backward to suture midway between the two transverse fasciæ; a broad transverse fascia at apical fifth extending from lateral margin to suture; along lateral margin there are also an oblong spot at basal third and a small round one midway between the two transverse fasciæ. Beneath golden green with a slight cupreous reflection; tarsi piceous.

Head nearly flat, with a broad, moderately deep longitudinal groove extending from occiput to a deep transverse groove in

front of epistoma; surface sparsely but coarsely and irregularly rugose on front, and coarsely punctate, the punctures deep and irregularly placed, forming numerous irregular impunctate areas, and sparsely clothed with a few inconspicuous recumbent hairs arising from the punctures; epistoma smooth, concave, and very broadly arcuately emarginate in front, the emargination feebly sinuate at middle; eyes large, elliptical and parallel on front; cheeks armed with a large tooth, which is rather acute at apex. Antennæ piceous (first joint æneous), reaching to middle of pronotum and serrate from the fourth joint; first joint clavate and feebly arcuate; second elongate, cylindrical; third shorter and slenderer; following joints triangular, except the last one, which is oblong and acute at apex. Pronotum strongly transverse and moderately convex, nearly twice as wide as long, base and apex about equal in width, widest at middle, with a broad shallow impression on each side of disk near apical margin, and a broad, irregular one on each side along lateral margin, and also with a broadly concave impression along base, which does not extend to lateral margins, and leaving an obsolete elevated area near posterior angles, but without a distinct lateral carina; sides broadly arcuately rounded, with the margins feebly irregularly crenulate; posterior angles broadly rounded; anterior margin deeply arcuately emarginate, with the median lobe broadly rounded and the anterior angles acute; base deeply sinuate, with a broad median lobe, which is truncate and feebly emarginate in front of scutellum; surface coarsely and irregularly punctate, the punctures deep and connected to each other in irregular series by deep sinuate grooves, irregularly distributed, the grooves becoming somewhat concentric on disk, and from each puncture arises an inconspicuous recumbent cinereous hair; intervals smooth and shining. Scutellum subcordate, acuminate at apex; surface finely densely reticulate, with a few coarse punctures in middle. Elytra moderately convex, feebly flattened near apex, about equal in width to pronotum at base, with a rather deep basal impression, and a narrow, deep groove, extending from the humeral angles to middle of elytra; sides sinuate in front of middle, slightly expanded at anterior transverse fascia, then obliquely attenuate to tips, which are obliquely truncate, rounded at sutural angles, and with the margins strongly dentate, the teeth becoming more irregularly placed and less distinct along anterior half of elytra; humeral angles obtusely angulated; humeri prominent; surface strongly and densely rugose, the

rugæ shining and more elevated and transverse on the golden green areas, with the impressions coarsely and rather densely ocellate-punctate, sparsely clothed with rather coarse recumbent hairs, which are cinereous on the golden green areas and black on the cyaneous spaces. Abdomen beneath deeply and rather densely punctate, the punctures smaller at apex and connected to each other by a sinuate groove on the lateral parts of segments, sparsely clothed with recumbent cinereous hairs, the hairs becoming denser toward sides of segments; last ventral segment broadly rounded and subtruncate at apex; posterior coxæ more densely pubescent than rest of body. Mesosternum and metasternum coarsely punctate, the punctures connected by coarse sinuate grooves. Prosternum uneven, declivous in front; anterior margin with a narrow lobe, which has the anterior margin broadly arcuately emarginate, forming a strong toothlike lobe on each side; prosternal process flat, broadly rounded at apex, the surface with vermiculate grooves, in the bottom of which are numerous moderately deep punctures, from the center of which arises a semi-erect cinereous hair. Legs finely densely reticulate, and sparsely scabrous; tarsal claws bifid, inner tooth about one-half as long as outer one, and acute at apex.

Length, 14 millimeters; width, 4.75.

Type locality.—Sibuyan Island, Philippines.

Type.—Catalogue No. 25948, United States National Museum.

This beautiful species is described from a single specimen from Sibuyan Island, collected by Prof. C. F. Baker (*Baker 18977*).

This species, in color and markings, resembles somewhat *Polyonychus nigropictus*, described by Castelnau and Gory from India, but is separated from that species by the eyes being parallel and not oblique, and the prosternal lobe being armed with a large tooth on each side, while in *P. nigropictus* the lobe is entire. Kerremans erected the genus *Cisseicoraebus* for three species, *grandis* Kerremans, *retrolatus* Deyrolle, and *subcornutus* Fairmaire. From *subcornutus* it is easily separated by not having the head tuberculate, and from *grandis* and *retrolatus* by the pronotum not being densely pubescent, and by the coloration and markings on the elytra.

EINIGE NEUE ANOMALA-ARTEN DER PHILIPPINEN

Von FR. OHAUS

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Anomala vigilax sp. nov.

Zur Gruppe der *varicolor* Gyll. gehörend. Gestreckt oval, hinten kaum verbreitert, ziemlich hoch gewölbt. Oben und unten gelbbraun, der Kopf, die Scheibe des Thorax und das Schildchen dunkler braun mit grünem Erzschilder, die Seiten der Deckflügel, die Tibien und Tarsen braun; Oberseite glänzend, kahl, nur die Seiten des Halsschildes und der Deckflügel, die Unterseite und Beine mit langen rotbraunen Haaren. Kopfschild fast parallelseitig mit hoch aufgeworfenem Rand, wie die Stirn leicht vertieft, dicht und kräftig runzelig, Scheitel, Halsschild, und Schildchen kräftig einzeln punktiert, Halsschild mit Seitengrübchen und einem kurzen schiefen Eindruck dahinter; basale Randfurche nicht unterbrochen. Auf den Deckflügeln sind die primären Punktreihen regelmässig gefurcht, die Rippen kaum höher als die Interstitien, von den letzteren das subsuturale unregelmässig punktiert, das zweite und dritte mit je einer einfachen Punktreihe. Afterdecke dicht und fein runzelig mit einzelnen grossen haartragenden Ringpunkten dazwischen. Vorderschienen ohne Andeutung eines zweiten Seitenzahnes. Beim ♂ ist an den Vorderfüssen die innere (grössere) Klaue einfach, an den Mittelfüssen die äussere gespalten; die Fühlerkeule so lang wie die Geissel.

Länge, 12 Millimeter; Breite, 6; ♂.

LUZON, Provinz Benguet, Trinidad, 6,000 Fuss, Mai, 1914 (G. Boettcher).

Anomala apogonioides sp. nov.

Aus der Verwandtschaft der *leotaudi* Bl., in Körperform und Färbung einer *Apogonia* ähnlich. Gestreckt oval, ziemlich stark gewölbt, oben und unten gleichmässig dunkelbraun mit kupferigen Bronzeschimmer, schwach glänzend, nur die Fühler braungelb. Kopfschild und Stirn dicht runzelig, Scheitel, Halsschild und Schildchen dicht und ziemlich kräftig einzeln punktiert, die beiden letzteren mit angedeuteter Mittelfurche, die

basale Randfurche in der Mitte nicht unterbrochen. Auf den Deckflügeln sind die primären Punktreihen leicht gefurcht, die Interstitien unregelmässig punktiert, die ganze Oberfläche mit feinen Pünktchen überstreut. Die Afterdecke ist sehr dicht und fein gerunzelt, neben der etwas höckerigen Spitze beiderseits leicht eingedrückt, mit einzelnen langen Borstenhaaren. Abdominalsternite und Hinterbrust mit einzelnen grossen Ringpunkten, aus denen gelbe Borsten entspringen. Vorderschienen mit spitzem Spitzen- und Seitenzahn. Forceps ähnlich dem der *leotaudi*.

Länge, 13 Millimeter; Breite, 6.5; ♂.

MINDANAO, Provinz Surigao, Surigao, 21 Mai, 1915 (*Boettcher*).

Anomala quadricalcarata sp. nov.

Zur Gruppe der *sulcatula* Eschsch. gehörend. Gestreckt oval, rotbraun bis schwarzbraun mit grünem Erzschilder, Oberseite kahl, lebhaft glänzend, Unterseite und Beine graugelb behaart. Kopf und Kopfschild, Thorax und Schildchen sind dicht und Kräftig punktiert. Auf den Deckflügeln sind die primären Punktreihen ganz regelmässig, an den Seiten und beim Hinterrand leicht gefurcht, auf der Scheibe hinter dem Schildchen ist die Punktierung flacher und durch feine Querrunzeln unterbrochen; die zweite primäre Rippe trägt eine unregelmässige Punktreihe von der Basis bis zum Hinterrand, die dritte innen neben der Schulter nur einige wenige Punkte. Afterdecke dicht und fein runzelig, matt. An den Vorderschienen ist der Seitenzahn klein, aber scharf, der Spitzenzahn beim ♂ kurz und spitz, beim ♀ etwas länger, leicht gerundet, nicht verbreitert. Bei ♂ und ♀ sind an den Hinterbeinen die Trochanteren verlängert, scharf vorspringend, die Tibien auf der Mitte der Innenseite mit einem grossen Zahn versehen. Der Forceps ist ähnlich dem der *sulcatula*, es fehlt jedoch auf der Aussenseite der Parameren die gebogene Kante.

Länge, 12 bis 14 Millimeter; Breite 6.5 bis 7; ♂, ♀.

SIBUYAN (*Baker*).

Anomala (Spilota) moseri sp. nov.

Zur Gruppe der *picturata* Cand. gehörend. Oberseite rotgelb und schwarz, Unterseite hellgelb mit einigen schwarzen Flecken. Kopfschild und Kopf rotgelb, nur auf dem Scheitel zwei kleine punktförmige schwarze Fleckchen; Kopfschild und Stirn dicht runzelig, matt, der glänzende Scheitel mit einzelnen feinen Punk-

ten. Halsschild rotgelb mit fünf schwarzen Flecken, zwei streifenförmigen an den Seiten, die weder den Vorder- noch den Hinterrand berühren, zwei dreieckigen auf der Scheibe neben der Mittellinie, und einem grossen an der Basis in der Form eines lateinischen V; die Punkte sind an den Seiten grob und dicht, auf der Mitte fein und einzeln. Schildchen schwarz mit einigen feinen Pünktchen an der Basis. Deckflügel schwarz, ein Querstreifen an der Basis, eine zackige Querbinde, die vom Aussenrand neben und hinter der Schulter bis zur Spitze des Schildchens zieht, und eine in einzelne Fleckchen aufgelöste Querbinde hinter der Mitte rotgelb; die primären Punktreihen sind tief gefurcht, primäre Rippen und Interstitien gewölbt, im subsuturalen Interstitium eine Punktreihe von der Basis bis zum Hinterrand, im zweiten Interstitium einzelne grobe Punkte. Propygidium schwarz mit zwei kleinen hellgelben Flecken an der Seite; Pygidium schwarz mit breitem gelbem Mittelstreifen. Unterseite hellgelb, ebenso die Beine, nur die Schenkel mit einem schwarzen Fleck; die Spitze der Hinterschienen und alle Tarsen schwarz.

Länge, 13 Millimeter; Breite, 7; ♂.

MINDANAO, Provinz Surigao, Surigao (*Boettcher*).

THE GENUS MAKILINGIA (JASSOIDEA) IN THE PHILIPPINES

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TWO PLATES

Makilingia,¹ which is a member of the Gyponidæ, subfamily Sudrinæ, is undoubtedly a sudrine gyponid, instead of hylicine, as stated in my original paper. Since 1914 considerable additional material has accumulated, and it is now possible to present a more comprehensive treatment.

The five species first described came from the two great mountains of central Luzon, Maquiling and Banahao. We now find that the genus is more richly represented in the mountains of northern Luzon,² but also may occur at low altitudes, as well as in other islands of the Archipelago, south to Mindanao. A few of the species are abundant and widely distributed, while the remainder appear to be of very local distribution, so far as present knowledge goes. The genus appears to be confined to the Philippines and even more peculiarly characteristic of this fauna than are the pachyrrhynchid beetles. Fifteen new species and varieties are here presented. Exploration of the vast unknown mountainous regions of the Archipelago will undoubtedly produce many more.

There is a superficial resemblance in general form, between this genus and the Japanese genus *Epiacanthus* of Matsumura,³ but the latter possesses a totally different head structure and is, moreover, a tettigoniellid, not a gyponid.

In my earlier paper sufficient stress was not laid on the structure of the scutellum, which is highly characteristic of the genus. The raised apical portion is preceded by a wide transverse depression, very evident in lateral view (Plate 1, fig. 2, b). The fronto-clypeal suture is absent in all the species, the

¹ Baker, C. F., Philip. Journ. Sci. § D 9 (1914) 409.

² Nothing like thorough collecting has yet been done on Maquiling and Banahao.

³ Termes, Fuz. (1902) 354.

clypeus being relatively of great size. Also characteristic of the genus is the distally narrowed median apical cell (Plate 1, fig. 2, *b*; Plate 2, fig. 6, *c*; fig. 9, *b*). The ovipositor does not extend beyond the pygofer, and the genitalia are always considerably exceeded by the tegmina. The last sternite of the male is very characteristic, being greatly enlarged and usually swollen. The male plates are very diverse in form, sometimes coalesced at base, and this portion may be greatly enlarged.

There is usually marked sexual dimorphism in the form of the head, and may be in coloration as well, in certain species. The heads of males are a little shorter and the apical margin is more broadly arcuate. The color change in the sexes usually consists of reds and yellows being replaced by black, the former markings being occasionally reduced or obliterated in the male. In some species, such as *speciosa* and *colorata*, the colors of males and females may be practically identical. In most of the species, pale yellow markings may vary to reddish or vice versa. In all of the species the two basal joints of antennæ are pale yellow in color.

In *M. tettigonoides* the rostrum is densely clothed with long, stiff, appressed, yellowish hairs. In *M. speciosa* these hairs are long, but far fewer in number. In all the other species they are short and inconspicuous.

The hind tibiæ are armed with three rows of numerous very stout spines of medium length and one row of stout bristles. The fore femora have a short longitudinal row of small erect bristles on distal half beneath. The fore tibiæ have a single row of spines beneath extending the entire length.

Synopsis of the species of Makilingia.

- a*¹. Clypeus basally strongly umbonate; very large robust species (7.5 to 10 millimeters) with broad, short heads; front shagreened.
- b*¹. Greenish yellow, with black markings on vertex and pronotum.
 - M. tettigonoides* sp. nov.
- b*². Black, with reddish markings beneath and on fore margin of vertex and tegmina of two shades of reddish beyond the black basal fourth *M. speciosa* sp. nov.
- a*². Clypeus basally gently convex or very slightly raised; small slender species with heads usually longer for the total width.
- b*². Front shagreened, sometimes also with small separated punctures.
- c*¹. Front uniformly shagreened, without punctures.
- d*¹. Vertex always more or less punctured and wrinkled.
- e*¹. Tegmina bronzy or greenish fading to brownish; lateral margins of head broadly red, ivorylike callose, as is also basal border of clavus; length 5 to 5.5 millimeters.

M. colorata Baker.

- e*². Tegmina black, with reddish or yellowish markings or with none; sometimes with pale costal spots; markings of vertex not shining callose.
- f*¹. Tegmina reddish or yellowish marked, at least a narrow commissural line.
- g*¹. Lateral spots of vertex small and distant from eyes, or absent.
- h*¹. Pronotum without distinct transverse rugæ; punctures on base of tegmina smaller, more separated, and with smooth interspaces; costal area subapically with a pale macula; emargination of female genital sternite with a median tooth.
- i*¹. Commissural yellow macula occupying a large part of clavus; spots on vertex four and reddish.
M. maculata Baker.
- i*². Commissural mark reduced to a narrow marginal line; spots on vertex two, large, yellowish.
M. sibuyanensis sp. nov.
- h*². Pronotum with distinct transverse rugæ; punctures on base of tegmina large, crowded, with raised margins between; costal area subapically without pale macula, emargination of female genital sternite evenly arcuate; commissural macula narrower than in *maculata*, sometimes with a yellow dash exterior to it, and in males may be reduced to a slender commissural line *M. variabilis* sp. nov.
- g*². Lateral spots of vertex very large, adjoining eyes, and occupying a large part or all of lateral margins of vertex.
- h*¹. Clavus entirely bordered with reddish.
- i*¹. Disk of clavus with two small reddish dots or these coalesced to form an oblique crossband.
M. banahaoensis sp. nov.
- i*². Disk of clavus immaculate..... *M. haightiana* sp. nov.
- h*². Clavus not reddish bordered.
- i*¹. Clavus pale yellowish with two dark discal stripes; eye above entirely yellow bordered.
M. lineata sp. nov.
- i*². Clavus black, with a slender yellowish commissural line; postocular area black. *M. surigaoensis* sp. nov.
- f*². Tegmina entirely black, except for decolored costal areas; lateral spots of vertex very large but not adjoining eyes.
- g*¹. Tegmina with decolored costal border; front with basal border yellowish; tegminal punctures shallow and well separated; emargination of female genital sternite with a median tooth..... *M. panayensis* sp. nov.
- g*². Tegmina without decolored costal border; entire front yellowish; tegminal punctures coarse and crowded; emargination of female genital sternite evenly arcuate.
M. bimaculata sp. nov.

- d*². Vertex almost entirely smooth, without punctures or wrinkles; ocelli nearer to each other than to eyes.
- e*¹. Small (length, 5 to 5.5 millimeters); white or pale yellowish throughout *M. pallida* Baker.
- e*². Larger (length, 6.5 millimeters); black, with yellowish legs, genitalia, front, and marks on vertex.. *M. woodworthi* sp. nov.
- c*². Front shagreened, but also with small, deep, mostly separated punctures; largely black.
- d*¹. Tegmina without pale costal area.
- e*¹. Clypeus emarginate at apex; puncturation above very coarse and thick; length 7 millimeters..... *M. pruinosa* Baker.
- e*². Clypeus with narrowly rounded apex; punctures shallow and well separated; length, 5 to 6 millimeters.... *M. nigra* Baker.
- d*². Tegmina with a broad, elongate, whitish, translucent costal area on distal half..... *M. costalis* sp. nov.
- b*². Front without shagreening and with large separated punctures but otherwise smooth, shining; female genital segment medially deeply roundly bisinuate emarginate..... *M. frontalis* sp. nov.

Makilingia tettigonoides sp. nov. Plate 1, fig. 1.

Female.—Length, 8 millimeters. Ochraceous to yellowish; abdomen black with pale segmental margins; tegmina, except costal margins greenish to near apical cross veins, the apices slightly smoky; vertex (Plate 1, fig. 1, *a*) with four black spots, two marginal near apex, and two surrounding ocelli; on infero-posterior surfaces of eyes, beneath posterior margin of vertex and entirely hidden from view without separating the head from pronotum, are two black spots; pronotum with two black spots just behind eyes; large black spots also occur on basal angles of scutellum; basal lateral angles of front narrowly black.

Front strongly convex, medially shallowly depressed, very faintly shagreened, smooth, shining. Clypeus strongly roundly umbonate basally, with surface like that of front. Genæ and loræ with shallow separated punctures. Vertex strongly depressed before the sharp anterior margin, as usual in this genus, the remainder of surface separated into three portions by low rounded longitudinal prominences along the lines of the ocelli, the lateral concavities much the deeper; the median area minutely and sparsely punctured, the lateral areas wrinkled next eyes. Ocelli large, equidistant from basal and antero-lateral margins of vertex and nearer to eyes than to each other. Pronotum uniformly covered with separated punctures, the interspaces smooth, and transverse rugæ not evident. Tegminal punctures well separated, the interspaces smooth. Genital segment apically broadly, deeply, arcuately emarginate.

Male.—Length, 7.5 millimeters. Vertex more broadly rounded apically. Color inclining to testaceous (as is sometimes the case in females). Meso- and metasternal sclerites black. Spots of vertex enlarged and variously coalesced. A common type is represented in males from Baguio (Plate 1, fig. 1, *c*) though many minor variations of this occur. A male color form from Dapitan (Plate 1, fig. 1, *d*) shows complete coalescence of the black spots across disk of vertex. Females occasionally have the male type of marking, and one Baguio female is selected (Plate 1, fig. 1, *b*) which is very similar to Dapitan males. The vertex is finely wrinkled anteriorly also, and has two small deep depressions near basal margin. Genital segment as long as broad, roundly swollen, shining black, hind margin nearly truncate except for a short, acute, median projection; base of the long slender plates very broad, undivided, and swollen.

LUZON, Benguet Province, Baguio and Pauai (Haight's place): Nueva Vizcaya Province, Imugan. MINDANAO, Zamboanga Province, Dapitan (*Baker*).

Makilingia speciosa sp. nov. Plate 1, fig. 2.

Female.—Length, 10 millimeters. Black, venter, femora, and tarsi reddish, tibiae piceous; lateral margins of cheeks, anterior margin of vertex and narrow posterior border of pronotum yellowish; basal fourth of tegmina and costal margin black, this followed by a broad reddish crossband, remainder pale brown.

Front and clypeus formed as in *M. tettigonoides*, but surface strongly granulate shagreened. Genæ, in the deep concavity, with shallow separated punctures, but none on the yellow border; below and on loræ becoming coarser and with a few rugæ. Vertex (Plate 1, fig. 2, *a*) with median area a little elevated, with coarser, very sparse punctures, and with a deep, subtriangular depression at apex; ocelli large, a little nearer to basal than to antero-lateral margins and nearer to eyes than to each other. Pronotum and scutellum (Plate 1, fig. 2, *b*) as in *M. tettigonoides*. Tegminal punctures much coarser. Genital segment (Plate 1, fig. 2, *e*) medially cross-striate, medially and posteriorly black, the hind margin evenly arcuately emarginate.

Male.—Length, 9 millimeters. Colored like the female. Genitalia (Plate 1, fig. 2, *d*) of remarkable structure, the stout plates arising from a solid base which is extended to one and a half times the length of genital segment. The latter, while charac-

teristically swollen, is comparatively small, with hind margin medially acutely extended.

LUZON, Benguet Subprovince, Baguio (*Baker*). The most conspicuous species of the genus, but apparently rare, only four specimens having been taken.

Makilingia colorata Baker.

Described from Mount Maquiling. We now have specimens of this beautiful and very distinct species from Malinao, Tayabas Province, Luzon; from the Cuernos Mountains of Negros; and from Butuan, Agusan Province, and Surigao, Surigao Province, in Mindanao.

Makilingia maculata Baker.

Originally described from Mount Banahao and Mount Maquiling, this species has since been taken in Malinao, Tayabas Province, Luzon; in Surigao, Surigao Province, and Zamboanga, Mindanao; and in Basilan and Sibuyan Islands.

Makilingia sibuyanensis sp. nov. Plate 1, fig. 3.

Male.—Length, 5.5 millimeters. Black; four marginal spots on vertex and upper border of front (Plate 1, fig. 3, *a*), legs, last ventral segment, and a slender line on claval commissure pale yellow. With a subapical pale spot on costal margin of tegmina, as in *maculata*.

Front, with clypeus, thickly granulate shagreened throughout; clypeus slightly raised basally, but not umbonate as in *M. tettigonoides*, though its outlines are similar to that of the latter species. Genæ and loræ with shallow separated punctures. Vertex with median area gently convex and very sparsely punctate, the lateral depressions nearly smooth except for very strong and irregular wrinkles in postero-lateral corners. Ocelli very large, equidistant from basal and antero-lateral margins, but farther in front of anterior line of eyes than usual and but very little farther from each other than from eyes. Pronotum uniformly covered with large separated punctures, the interspaces smooth and with no indication of transverse rugæ. Genitalia (Plate 1, fig. 3, *b*) of ordinary type.

Female.—Length, 5.75 millimeters. Similar to *maculata*, the large median macula on clavus being of quite the same form as may occur in *maculata*. Vertex with four marginal spots, as in the male; the apical spots in both sexes are larger than the lateral, not smaller as in *maculata*. Genital segment black

medially; hind margin with a shallow subrectangular median emargination.

SIBUYAN (*Baker*). It is interesting that *maculata*, found in Luzon and Mindanao, should be replaced in an intermediate island by a very similar but entirely distinct species. Sibuyan is rich in endemic species of many groups, though many species of Sibuyan are also found in Romblon and northern Panay, and this one, also, may occur there.

***Makilingia variabilis* sp. nov.** Plate 1, figs. 4 and 5.

Black; yellow markings in certain forms very similar to those of *maculata*, but very variable and with striking sexual dimorphism. In the fully colored female forms, in addition to the large common claval macula, there is a small separated spot or dash near the middle of clavus and on the adjoining border of the corium; when these lateral spots are lacking, then the median macula is narrower than in *maculata*; associated with females so marked are males which have the median macula a little narrower but also possess the lateral spot. At times series of females (var. *simillima*) may be taken, all of which have a much narrowed median macula on clavus, lack the lateral spots on corium inner border, and usually lack the apical spots of vertex (Plate 1, fig. 5, *a*); associated with these are males in which the median macula is reduced to a slender commissural line (as also in occasional females) and the spots of vertex (Plate 1, fig. 5, *b*) are entirely lacking. The tegmina have no subapical pale costal spot, but midway, next costal margin, may occur a small waxy pruinose area, though this is usually rubbed off.

Female.—Length, 5.25 millimeters. Front evenly convex, the clypeus slightly raised at base, both thickly granulate shagreened. Genæ and loræ sparsely coarsely punctate. Vertex, behind sharp fore margin, evenly depressed from eye to eye, the median basal area evenly gently convex, and sparsely small punctured; surface next eye and somewhat along fore border wrinkled, the wrinkles much stronger in posterior lateral corners. Ocelli very large, equidistant from basal and antero-lateral margins, and a little farther from each other than from eyes. Pronotum uniformly covered with shallow separated punctures and basally with distinct indications of transverse rugæ. Tegminal punctures well separated, with smooth interspaces. Genital segment broadly, shallowly, arcuately emarginate behind.

Male.—Length, 4.75 millimeters. Genital segment brown, much longer than broad, rapidly broadening caudad, the hind margin with an obtuse median projection which is yellow. Plates as long as genital segment, blunt tipped and testaceous in color.

LUZON, Benguet Subprovince, Baguio and Pauai (Haight's place): Nueva Vizcaya Province, Imugan. MINDANAO, Zamboanga Province, Dapitan. The fully colored typical form and the var. *simillima* occur together in all localities. It would have been difficult to understand this variable species without large series. The genitalia are uniform throughout.

Makilingia banahaoensis sp. nov. Plate 2, figs. 6 and 7.

Black; legs yellowish; head with two small reddish apical spots (Plate 2, fig. 6, *a*) and two very large lateral spots, the latter adjoining eyes; in the var. *montalbanensis*, the subapical spots are coalesced in one large apical spot. Clavus apparently broadly bordered with reddish, very slenderly on median portion of commissure, broader at apex of clavus, the outer reddish stripe being actually located on the corium, along the claval suture; disk of clavus with two reddish dots obliquely placed, and these, in the var. *montalbanensis* (Plate 2, fig. 7, *a*), are coalesced into an oblique stripe, this with the basal and apical reddish borders being much broader than in the typical form. Abdomen with narrowly pale segmental margins.

Female.—Length, 5.25 millimeters. Front gently convex, the clypeus not raised basally, both thickly evenly granulate shagreened; genæ and loræ rather thickly and coarsely punctate. Vertex but little depressed anteriorly and laterally, more strongly so near eyes and medially just before apex; median area very gently convex and more strongly and thickly punctured than in *maculata* and allies. Ocelli of medium size, equidistant from basal and antero-lateral margins, and about as near eyes as to each other. Pronotum with shallow separated punctures and with distinct indications of numerous transverse rugæ. Tegminal punctures well separated and with smooth interspaces. Genital segment broadly deeply marginate, this emargination with a second median subrectangular emargination.

Male.—Length, 4.25 millimeters. Color markings as in female. Genital segment subtriangular, the broad apex nearly equaling length and nearly truncate, without median extension. Plates together forming a long acute triangle, longer than genital segment.

LUZON, Laguna Province, Mount Banahao. The more heavily marked var. *montalbanensis* is from Montalban, Rizal Province.

Makilingia haightiana sp. nov. Plate 2, fig. 8.

Similar to *M. banahaoensis*. Black, legs pale yellow; vertex (Plate 2, fig. 8, *a*) with two very large reddish lateral spots extending from eyes to two-thirds of lateral margins, and a transverse apical spot which is very rarely divided into two, and which is, in the male, completely coalesced with lateral spots forming a continuous red border to vertex except for small black spots left on lateral margin at one-third before apex. Cheeks broadly pale yellow bordered in the female; face entirely yellow in the male. Clavus bordered with reddish yellow, but stripes along suture and commissure very narrow, the apex of clavus not filled with color, and no discal markings. Entire apical area of tegmina subhyaline, with narrow dark apical margin.

Female.—Length, 6 millimeters. Front and clypeus as in *M. banahaoensis*; genæ and loræ shallowly and sparsely punctured. Vertex with shallow lateral depression, the entire median area from between ocelli forward strongly concave; median area strongly thickly punctured, entire basal area strongly wrinkled, some sharp and prominent curved wrinkles passing from outer margins of ocelli to basal margin. Ocelli large, nearly equidistant from basal margin, antero-lateral margins, eyes, and each other. Pronotum with separated punctures and strongly, thickly, transversely rugose over nearly entire surface. Tegminal punctures in great part larger and more thickly placed than usual, especially near claval suture. Genital segment subtruncate posteriorly.

Male.—Length, 5 to 5.5 millimeters. Sharply distinguished by the completely yellow face. Genital segment very large and swollen, oblong elliptical, half again as long as broad, as broad basally as apically, brown, and cross-striate, the apical margin broadly arcuate. Plates very small, obtuse apically, coalesced for almost entire length, and scarcely half length of genital segment.

LUZON, Benguet Subprovince, Pauai (Haight's place) 2,400 meters altitude (*Baker*).

Makilingia lineata sp. nov. Plate 2, fig. 9.

Female.—Length, 6 millimeters. Black; face and legs ochraceous; vertex (Plate 2, fig. 9, *a*) with broad lateral borders reddish yellow from eyes to apex, the inner margins of these marks

sinuate, and extending to behind the eyes. Tegmina dark smoky, the broad costal border from basal third, and entire apical area subhyaline; clavi broadly yellowish white, leaving between these areas and the sutures two longitudinal smoky stripes. Abdomen yellowish white, pygofers and disks of tergites darker.

Similar in appearance to the male of *M. haightiana* but distinct in the following diagnostic characters: Front and clypeus far more finely shagreened. Ocelli a little nearer to both basal and antero-lateral margins than to each other, and nearer to each other than to eyes. Genital segment broadly subrectangularly emarginate behind, the emargination with a broad median tooth. *

LUZON, Nueva Vizcaya Province, Imugan (*Baker*).

Makilingia surigaoensis sp. nov. Plate 2, fig. 10.

Black; legs ochraceous; vertex (Plate 2, fig. 10) with two elongate yellowish spots extending from eyes to near apex, the inner margins of which are sinuate. Clavus with a very fine commissural yellowish line. Segmental margins of abdomen pale.

Female.—Length, 5 millimeters. Front and clypeus finely granulate shagreened. Genæ and loræ rugose-punctate. Vertex gently evenly concave anteriorly, deeply depressed between ocellus and eye, basal border laterally rather strongly wrinkled; median area with small sparse punctures. Ocelli slightly nearer to basal and antero-lateral margins than to each other, nearer to each other than to eyes, and remarkable in being little less distant from anterior than from basal margins. Pronotum with well-separated shallow punctures and without transverse rugæ. Tegminal punctures shallow, sparse, and inconspicuous. Genital segment with a broad subrectangular emargination, this having a large median tooth.

Male.—Length, 4.5 millimeters. With identical color markings. Genital segment yellow, large, subcircular, swollen, constricted before apex, the broadly rounded hind margin strongly reflexed. Plates black, shining, forming together an acute triangle about as long as genital segment, the acuminate tips strongly curved dorsad.

MINDANAO, Surigao (*Baker*).

Makilingia panayensis sp. nov. Plate 2, fig. 11.

Female.—Length, 5.25 millimeters. Black; legs, upper border of face, two small apical and two large lateral spots on

vertex (Plate 2, fig. 11) pale yellowish; narrow costal border from middle of tegmina decolored, this extended more broadly around apex to claval angle. Body above, in fresh specimens, with bluish white waxy pruinosity.

Front and clypeus thickly granulate shagreened. Genæ and loræ rather thickly, coarsely punctate. Vertex large, nearly as long as pronotum, evenly depressed back of sharp fore margin, from eye to eye; median area broadly convex and sparsely minutely punctured. Ocelli nearer to basal than to antero-lateral margins, and a little farther from each other than from eyes. Pronotum with coarse separated punctures and thickly transversely rugose. Tegminal punctures well separated, the interspaces smooth. Genital segment with a broad subrectangular emargination behind, this having a broad median tooth.

PANAY, Capiz Province, Navas (*Baker*).

Makilingia bimaculata sp. nov. Plate 2, fig. 12.

Black, shining; legs ochraceous; front, basal half of clypeus (all of the clypeus in the male), and two large lateral spots on vertex, yellowish (Plate 2, fig. 12, *a*).

Female.—Length, 7.5 millimeters. Front and clypeus very minutely granulate shagreened; lateral borders of clypeus nearly straight, anterior margins laterally reflexed. Genæ and loræ coarsely rugose-punctate. Vertex, in addition to the usual depressions, with a deep subrectangular median excavation reaching from apex halfway to ocellar line, the interior of this being finely longitudinally wrinkled; the median area is a little depressed along median line, convex either side to ocelli, the surface with coarse irregularly separated punctures. Ocelli large, nearer to basal than to antero-lateral margins and equidistant from eyes and from each other. Pronotum with coarse separated punctures and numerous, not sharply marked, transverse rugæ. Tegminal punctures coarse and crowded and extending beyond middle of tegmina. Genital segment (Plate 2, fig. 12, *c*) evenly arcuately emarginate behind.

Male.—Length, 5.5 to 6 millimeters. Genitalia similar to those of *M. surigaoensis* but the reflexed hind border of genital segment is very broad and whitish in color, the plates being testaceous (Plate 2, fig. 12, *b*).

LUZON, Benguet Subprovince, Baguio: Nueva Vizcaya Province, Imugan. MINDANAO, Zamboanga Province, Dapitan (*Baker*).

Makilingia pallida Baker.

Described originally only from Mount Maquiling, this species has also been taken at Malinao, Tayabas Province. A distinct variety (var. *benguetensis*), having an arcuate smoky line passing from tip of clavus to costal margin, has been collected at Baguio, Benguet Subprovince.

Makilingia woodworthi sp. nov. Plate 2, fig. 13.

Male.—Length, 6.5 millimeters. Black; legs ochraceous; front, basal portion of clypeus, borders of genæ, and two very large lateral spots on vertex (Plate 2, fig. 13, *a*) reaching to ocelli, yellow. Tegmina with a pale spot just beyond tip of clavus, and another larger one opposite to it on the costal border, the apical border decolored. Borders of abdominal segments yellowish.

Front and clypeus very finely granulate shagreened. Genæ and loræ coarsely rugose-punctate. Vertex with whole surface, except basal border, deeply evenly concave, the sharp anterior margin more strongly reflexed than in other known species; surface smooth, opaque, practically without punctures or wrinkles. Ocelli large, much nearer to basal than to antero-lateral margins and equidistant from each other and from eyes. Pronotum with large separated punctures and strongly, thickly, transversely rugose. Tegminal punctures large, thick set and extending to middle of tegmina (Plate 2, fig. 13, *b*). Plates large, together forming an acute triangle as long as the very broad genital segment, the latter being as broad apically as long, strongly swollen basally, the apical margin broadly arcuate.

LUZON, Laguna Province, Mount Maquiling (*Baker*). This very stout and well-marked species is named for Prof. H. E. Woodworth, who spent two very profitable years of entomological work at the foot of Mount Maquiling.

Makilingia pruinosa Baker.

This species was originally described from Mount Maquiling. It has since been taken on Mount Banahao, Laguna Province; at Baguio, Mountain Province; at Imugan, Nueva Vizcaya Province; and at Dapitan, Zamboanga Province, Mindanao.

Makilingia nigra Baker.

This species was originally described from Mount Banahao. It has since been taken on Mount Maquiling, Laguna Province; in the Cuernos Mountains of Negros; in northwestern Panay;

in Surigao, Surigao Province, Mindanao; and in Basilan. The punctures of front are much more crowded along the median line basally, in the female.

Makilingia costalis sp. nov. Plate 2, fig. 14.

Male.—Length, 5.5 millimeters. Velvety black; legs pale yellowish; tegmina black at extreme base, remainder dark smoky, an elongate whitish translucent costal area extending from basal third to apical cross veins, occupying entire area of subcostal cell.

Front finely shagreened and with numerous small deep punctures scattered sparsely over its surface; clypeus with punctures only at sides. Genæ and loræ with large scattered punctures. Vertex (Plate 2, fig. 14) nearly uniformly deeply depressed over entire surface, the median area with sparse minute punctures, the lateral areas with larger punctures and irregular wrinkles. Ocelli large, equidistant from basal and antero-lateral margins, and farther from each other than from eyes. Pronotum with shallow separated punctures but no indication of transverse rugæ. Tegminal punctures well separated and extending to one-third the length of tegmina.

MINDANAO, Surigao Province, Surigao (*Baker*).

Makilingia frontalis sp. nov. Plate 2, fig. 15.

Black, shining; covered with bluish white waxy powder when fresh; legs and abdomen (except for a spot on genital segment) ochraceous. Tegmina with the subcostal cell whitish translucent from basal fourth to apical three-fourths of tegmina, this area widest at middle.

Female.—Length, 6 millimeters. Head large and subtriangular; front and clypeus (except a small median basal granulate shagreened area) without shagreening, but covered with large, deep, separated punctures (like those of vertex and pronotum), the interspaces smooth and shining. Genæ and loræ thickly coarsely punctate. Vertex (Plate 2, fig. 15, *a*) with median area strongly convexly raised, a narrow and shallow submarginal depression extending around the vertex from eye to eye, the lateral depressions also being shallow; entire surface with large separated punctures; the sharp anterior margin but slightly raised. Ocelli large, a little nearer to antero-lateral than to basal margin, and nearer to eyes than to each other. Pronotum with very large, rather thickset punctures, the interspaces smooth and shining and with no indication of transverse rugæ.

Tegminal punctures close set and extending to two-thirds the length of tegmina. Genital segment with a deep roundly bisinuate median emargination (Plate 2, fig. 15, *b*).

Male.—Length, 5 millimeters. Coloring same as in female. The genitalia are most remarkable. The inflated genital segment, instead of being shortly acute medially, as usual, is here extended caudad in a long stout rapidly narrowing prolongation (Plate 2, fig. 15, *c*). The valves are also remarkable, being spatulate, covered with a dense short silvery pile, the apical margin with a row of short stiffly erect white hairs.

MINDANAO, Davao Province, Davao (*Baker*). This unique species represents as great a departure from the common type in one direction as *M. tettigonoides* does in another.

ILLUSTRATIONS

PLATE 1

- FIG. 1. *Makilingia tettigonoides* sp. nov.; *a*, ordinary type of female; *b*, female from Baguio with malelike markings; *c*, male from Baguio; *d*, male from Dapitan.
2. *Makilingia speciosa* sp. nov.; *a*, vertex and pronotum; *b*, head and pronotum, lateral view; *c*, face; *d*, male genitalia; *e*, female genital segment; *f*, tegmen; *g*, wing.
3. *Makilingia sibuyanensis* sp. nov.; *a*, vertex and pronotum; *b*, male genitalia.
4. *Makilingia variabilis* sp. nov., vertex and pronotum; *a*, female; *b*, male.
5. *Makilingia variabilis* var. *simillima* var. nov., vertex and pronotum; *a*, female; *b*, male.

PLATE 2

- FIG. 6. *Makilingia banahaoensis* sp. nov.; *a*, vertex and pronotum; *b*, face; *c*, tegmen.
7. *Makilingia banahaoensis* var. *montalbanensis* var. nov.; *a*, vertex and pronotum; *b*, head and thorax, lateral view; *c*, part of tegmen, showing two small interpolated abnormal cells.
8. *Makilingia haightiana* sp. nov., female; *a*, head and pronotum; *b*, upper part of face.
9. *Makilingia lineata* sp. nov.; *a*, vertex and pronotum; *b*, tegmen, apical portion.
10. *Makilingia surigaoensis* sp. nov., vertex and pronotum.
11. *Makilingia panayensis* sp. nov., vertex and pronotum.
12. *Makilingia bimaculata* sp. nov.; *a*, vertex and pronotum; *b*, male genitalia; *c*, female genital segment.
13. *Makilingia woodworthi* sp. nov., male; *a*, vertex and pronotum; *b*, genitalia.
14. *Makilingia costalis* sp. nov., vertex and pronotum.
15. *Makilingia frontalis* sp. nov.; *a*, vertex and pronotum; *b*, female genitalia; *c*, male genitalia.

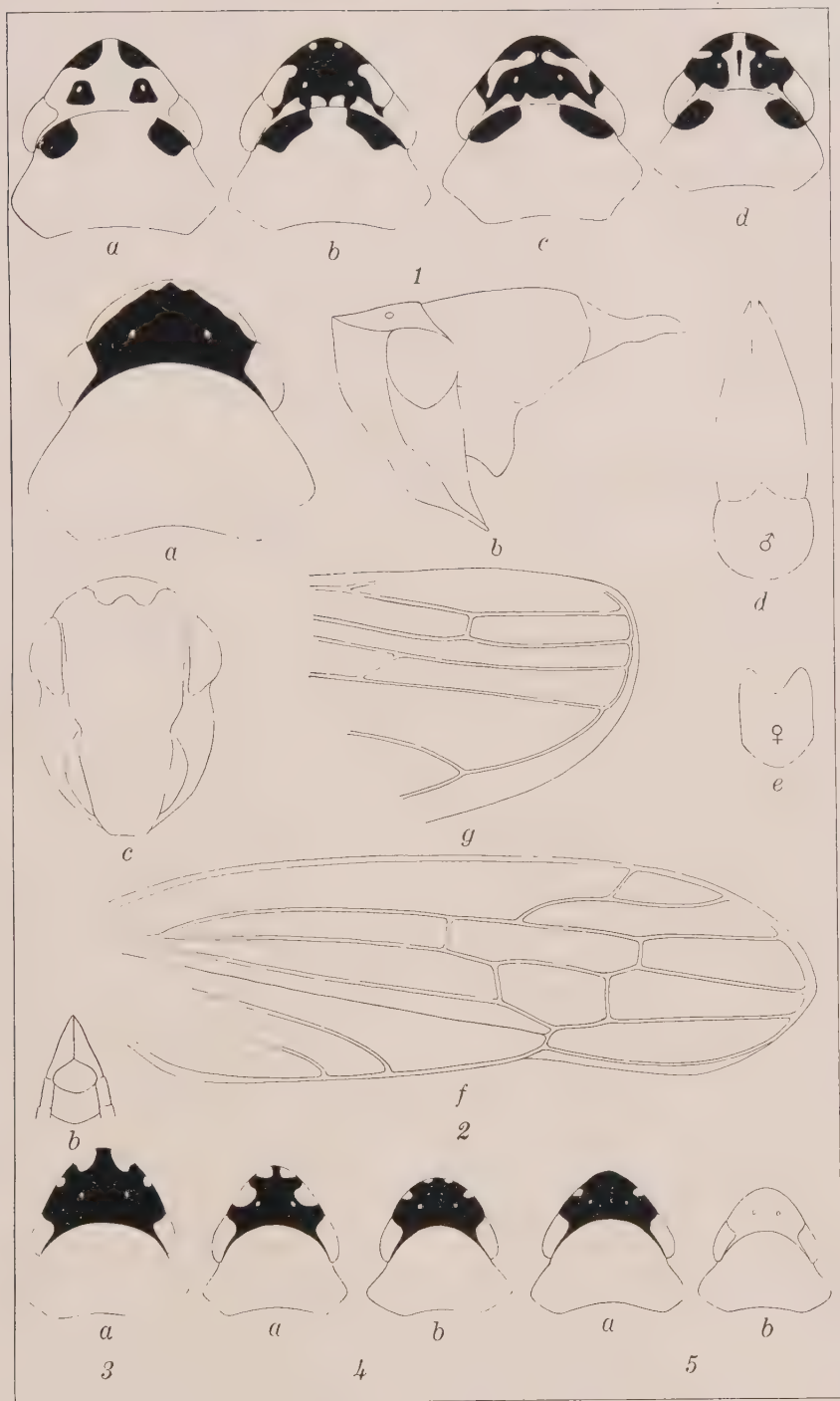


PLATE 1.

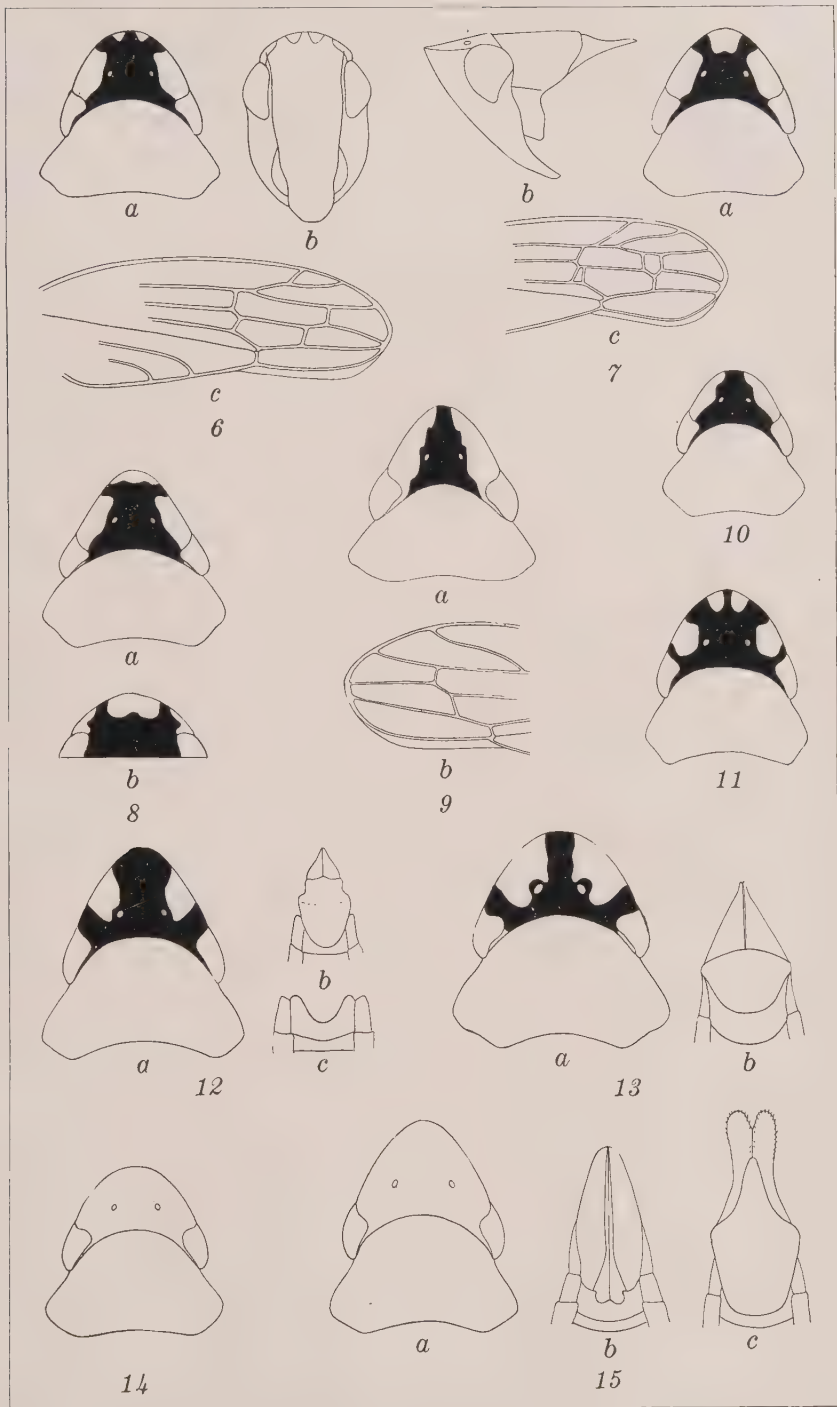


PLATE 2.

TWO DIPTERA PUPIPARA FROM PHILIPPINE BATS

By G. F. FERRIS

Of Stanford University, California

THREE TEXT FIGURES

The dipterous parasites of bats included in the two families Streblidæ and Nycteribiidæ are extremely well represented in the East Indian and Malayan regions. In fact, it is here that they seem to attain their greatest abundance, not only in number of species but in number of individuals as well. Yet, curiously enough, there appears to be practically no knowledge of the Philippine representatives of these groups. Indeed, I have been able to find no record of streblids and but one record of a nycteribiid from those islands, the latter being the somewhat dubious record of the occurrence of *Cyclopodia dubia* (Westwood). There are likewise few, if any, records of Hippoboscidæ.

Through the kindness of Dr. C. F. Baker I have been enabled to examine material representing one species of the first two of these families. This paper then may be regarded as the beginning of the study of the Philippine Diptera Pupipara. That a very extensive fauna of the three families Hippoboscidæ, Nycteribiidæ, and Streblidæ contained in the Pupipara will finally be revealed is unquestionable.

STREBLIDÆ

Nycteribosca gigantea Speiser. Figs. 1 and 2.

Nycteribosca gigantea SPEISER, Archiv für Naturgesch. 66¹ (1900) 46, fig. 1.

Previous records.—Known only from the original description, from the Bismarck Archipelago, of *Cephalotes peronii*. The male only has been described.

Present record.—From undetermined bats, Montalban, Rizal Province, Luzon, Philippine Islands. Collected by Edward H. Taylor. Three females and two males.

Female.—(Fig. 1.) Length, 4.5 millimeters. General color reddish brown, except for the head which is almost black with a pale median dorsal stripe and pearly eyes.

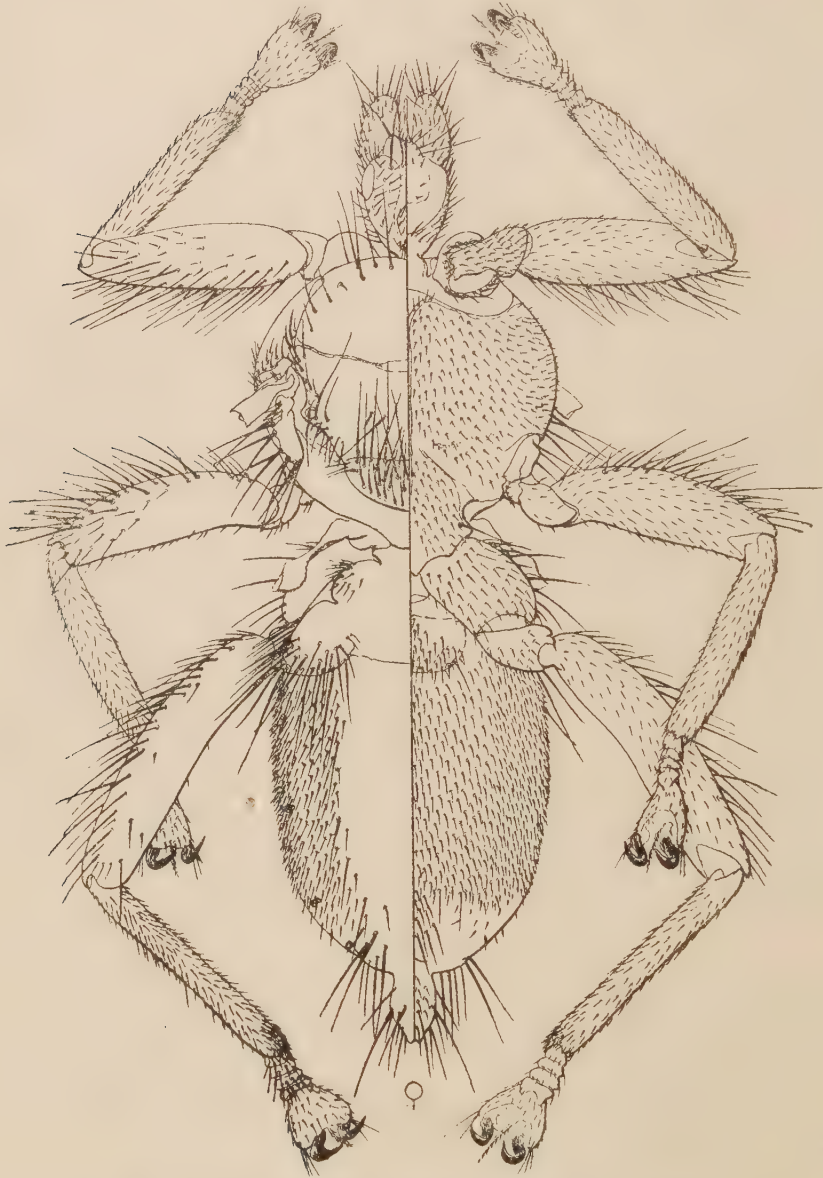


FIG. 1. *Nycteribosca gigantea* Speiser; female, wings removed.

Thorax almost spherical, somewhat flattened dorsally and ventrally. Pronotum with a few long setæ along the lateral margin. Mesonotum likewise with a few long setæ along the lateral margin, scutellum thickly beset with long, stout, upright setæ. Pleuræ, immediately in front of wings, with a few short,

stout setæ. Behind base of wings are what are apparently the squamæ, these bearing several long, stout setæ. Ventral side thickly beset with short setæ which are evenly disposed.

Wings (fig. 2, b) about as long as the body, the veins rather weak, disposed as indicated in the figure; beset throughout with minute setulæ.

Legs moderately stout, the hind legs only a little longer than the others, the anterior margins of femora with many long setæ, the ventral side of femora and all of the tibiæ thickly beset with small setæ. Tarsi five-segmented, the last segment much enlarged.

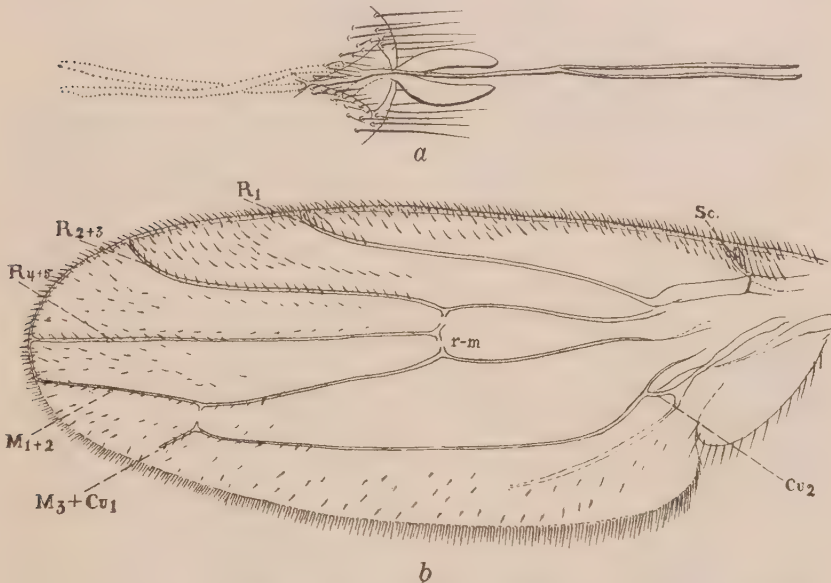


FIG. 2. *Nycteribosca gigantea* Speiser; a, genitalia of male; b, wing, wing veins labeled according to the Comstock-Needham system.

Abdomen with the basal tergite occupying about a fourth of its length and bearing many long setæ at the apical angles. Remainder of dorsum with numerous short setæ except for a median area occupying about a third or half of its width which is entirely naked. Apex of abdomen produced into a median lobe which bears several long setæ. Ventral side with an indistinct basal plate, this and the remainder of surface except near apex beset with many small setæ. Five pairs of spiracles present, these small.

Male.—Length, 4 millimeters. In general very similar to the female but with apex of abdomen conical, bluntly rounded, and

bearing many long setæ. No external claspers; internal genitalia (fig. 2, *a*) represented by two long, slender basal apodemes which articulate with a very slender apical piece of somewhat greater length that is divided into two slender forks. There are also two small flaplike pieces, which appear to articulate with a basal apodeme but are separate from the slender rods described.

According to Speiser this is the largest of the streblids. It has been known only from the male, and I am presenting a description and figures of the female and some further notes on the male.

NYCTERIBIIDÆ

Eucampsipoda philippinensis sp. nov. Fig. 3.

Specimens examined.—Two females and three males, from undetermined bat, Montalban, Rizal Province, Luzon, Philippine Islands. Collected by Edward H. Taylor. Holotype, a female, and allotype in the Stanford University collection, paratypes returned to Doctor Baker.

Female.—(Fig. 3, *a*.) Length, 2 millimeters. A rather small, pale-colored species.

Head slender and strongly arched, destitute of setæ dorsally except for three or four along anterior border; ventral side with a few small setæ; palpi long and slender, bearing four or five long setæ near tip. Eyes very small, consisting of a single facet.

Thorax very slightly longer than wide, forming nearly an equilateral triangle. Dorsal side destitute of setæ except for a single stout seta near each haltere. Ventral side rather sparingly beset with small setæ. Thoracic ctenidia very prominent.

Legs (fig. 3, *b*) rather short, the tibia with two transverse rings, the dorsal side of tibia and femur with numerous setæ of varying lengths, the ventral side nearly bare.

Abdomen almost completely membranous except for the basal tergite and sternite, a pair of weak subapical ventral plates, and the apical lobe. Basal tergite with numerous small and a few long setæ along margin. Remainder of dorsum thickly beset with small setæ and with an irregular cluster of long setæ in the median region. Apical lobe with several long setæ. Basal sternite with numerous small setæ on distal half and with about thirty-two setæ in the ctenidium. Chitinized plates near apex of abdomen bearing three or four long setæ, remainder of

venter beset with small setæ mingled with a few that are conspicuously larger.

Male.—Length, 2 millimeters. Head and thorax as in the female.

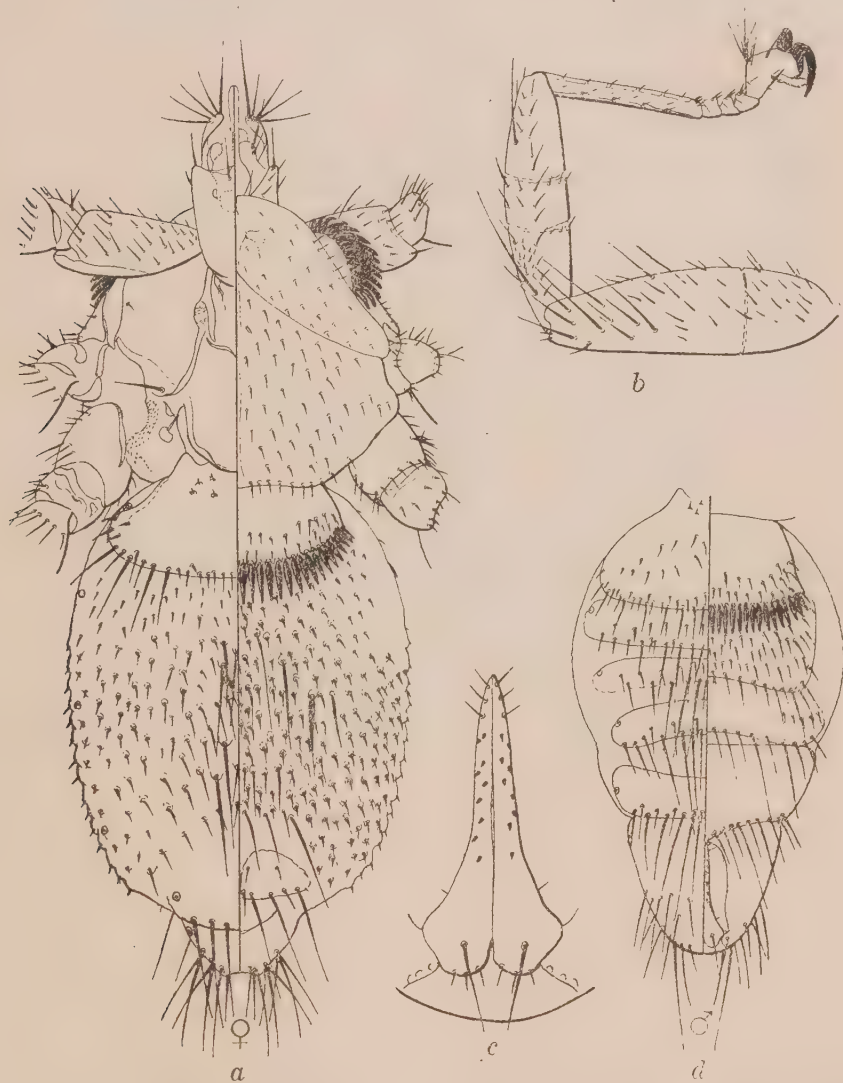


FIG. 3. *Eucampsipoda philippinensis* sp. nov.; a, female, legs removed; b, dorsal aspect of front leg; c, claspers of male; d, abdomen of male.

Abdomen (fig. 3, d) with the tergal and sternal plates rather weakly chitinized. Basal tergite with a few small setæ on disk and along margin. Second tergite extending nearly across ab-

domen, but short, bearing a few short setæ on disk and several setæ of variable lengths along margin. Third tergite narrower than second, but about as long, fourth still narrower, fifth somewhat broader, all these with long setæ along posterior margin. Terminal segment about a fourth as long as abdomen, broad, bluntly rounded at tip, and bearing numerous long setæ on apical half.

First sternite as in the female. Second nearly as long as first, bearing numerous small setæ on disk and longer setæ on margin. Third shorter than second, with long setæ on margin. Fourth as long as first, somewhat produced medially and with numerous setæ of varying lengths along posterior margin.

Claspers (fig. 3, c) slender, closely approximate, destitute of slender setæ except for three near apex, bearing a number of short, black, tuberclelike setæ.

Two species have heretofore been described in this genus. Of these, *Eucampsipoda aegyptia* (Macquart) has been recorded only from Egypt and is so inadequately described that it is scarcely recognizable. The other, *Eucampsipoda hyrtli* (Kolenati), has been recorded from Egypt, Senegal, Sumatra, Burma, Ceylon, and the Comoro Islands. I have at hand specimens from Ceylon. *Eucampsipoda philippinensis* is easily separable from this, in the female by the absence of the two groups of extraordinarily heavy setæ on the dorsum of the abdomen, and in the male by the presence of the small, black tubercles on the claspers. In the male of *hyrtli* these tubercles are entirely lacking and the claspers are fringed with small setæ of varying lengths.

ILLUSTRATIONS

TEXT FIGURES

- FIG. 1. *Nycteribosca gigantea* Speiser; female, wings removed.
2. *Nycteribosca gigantea* Speiser; *a*, genitalia of male; *b*, wing, wing veins labeled according to the Comstock-Needham system.
3. *Eucampsipoda philippinensis* sp. nov.; *a*, female, legs removed; *b*, dorsal aspect of front leg; *c*, claspers of male; *d*, abdomen of male.

GYRINIDÆ OF THE PHILIPPINE ISLANDS

By GEORG OCHS

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Through the kindness of Mr. W. Schultze, entomologist of the Bureau of Science, Manila, I received for determination the Gyrinidæ in the collection of that institution. I wish to thank Prof. C. F. Baker, of Los Baños, for placing at my disposal the material of his collection. Almost at the same time the well-known firm Dr. O. Staudinger and A. Bang-Haas, Dresden-Blasewitz, sent to me for examination a large amount of material of Gyrinidæ from the Philippine Islands. Among the material were two new species, which will be described herein. It is very remarkable that the largest and most-beautiful species of the genus *Orectochilus* from the Philippine Islands should come to our knowledge only now, and I suppose that in collecting systematically additional new species of Gyrinidæ will be discovered in that country, especially of the genus *Orectochilus*, as these Coleoptera often have a very local distribution.

All Gyrinidæ of the Philippine Islands known so far have been enumerated¹ with the exception of the two new species mentioned above. I propose to give in the following a recapitulation, adding thereto the remarks resulting from my last studies, also giving the chief characters of the different species, which will enable collectors to distinguish and to determine them.

Key to the known genera and species of Philippine Gyrinidæ.

a¹. The upper surface of insect without hairs.

b¹. About 6 millimeters long or longer, scutellum invisible..... *Dineutes*.

c¹. Length, 6.5 to 9 millimeters; flatly vaulted, attenuated to both ends, metallic dark below; elytra of male terminated exteriorly before the truncature with a small spine, of female straightly truncated..... *D. australis* F.

LUZON, Manila, several specimens in my collection (*v. Möllendorff, Koechlin, Boettcher*): Nueva Vizcaya Province, Imugan, 48 males and 83 females: Zambales Province: Laguna Province, Paete: Mountain Province, Butac, a series in some of which there is a greater number of males and in others the number

¹ Schultze, W., A Catalogue on Philippine Coleoptera, Bur. Sci. Spe. Publ. 7 (1915) 20.

of females is greater (*Staudinger*); Sablan (*Schultze*); Baguio (*Baker*). NORTHWESTERN PANAY (*Baker*). MINDANAO, Zamboanga (*E. Dexter Allen*).

This very common species is widely distributed and occurs also in Formosa, Sunda Islands, Malacca, Australia, New Zealand, and New Caledonia.

There is a variety of this species that is totally opaque reddish brown. In some males the apical spine of the elytra is reduced to a little sharp corner, especially among specimens from northwestern Panay, which moreover are remarkable by their very small size.

- c². Length 6 to 7.5 millimeters; in general smaller than the preceding, less flattened, attenuated chiefly to the fore part, red-yellow below, spines at exterior angles of elytra more prominent.

D. curtulus Rég.

LUZON, Nueva Vizcaya Province, Imugan, 1 male: Bataan Province, Zambales, 3 males and 16 females (*Staudinger*).

Régimbart described this species from a single male from Manila. *Staudinger's* material contained several females, the first known; these are completely like the male and are distinguished only by the anterior tarsus being much smaller, as is usual in the Gyrinidæ.

While Régimbart compares this species to *Dineutes sharpi* and *D. australis*, I would state that its nearest ally is *D. unidentatus* Aubé, of Ceylon, India, and China. I even doubt that *D. curtulus* should be considered a separate species; it seems, rather, to be only a variety. Perhaps the structure of the penis will help to solve the problem; unfortunately, the material at my disposal was insufficient for such study.

In comparison with *D. unidentatus* the species in question is broader and therefore appears shorter. The apical outline of elytra is very similar, but more prominent, and the median angle of the truncature much sharper, while in *D. unidentatus* it is mostly rather rounded. On the lateral portion of the elytra in *D. unidentatus* there is a very pronounced cavity, which is scarcely noticeable in *D. curtulus*. The sculpture of the elytra is alike in both species, being reticular with isolated punctures and scarcely impressed longitudinal striæ; the anterior tibiæ and tarsi do not present any particular differences, and it is characteristic of both species that the male and the female are alike in form, with the single exception of the anterior tarsus.

- b². Less than 6 millimeters long, scutellum visible..... *Gyrinus*.

- c¹. Epipleura black, below dark. Length, 3.5 to 4.5 millimeters; short-oval, highly vaulted, the seventh interstice on elytra evidently convex; elytra, especially on the lateral portion, strongly reticulated..... *G. sericeolimbatus* Rég.

LUZON, Mountain Province, Baguio (*Baker*). Also known from Celebes, Java, Sumatra, and New Guinea.

c². Epipleura red, below more or less red.

d¹. Length, 5 to 6 millimeters, oblong-oval, elytra of male finely punctate, of female more so, the punctures of series small; tip of elytra with rounded angles *G. tenuistriatus* Rég.

This species, described by Régimbart from the Philippine Islands, was not represented in my material.

d². Length, 5 millimeters, elongate-oval, posteriorly attenuated. Elytra, at least of male, entirely smooth, the punctures of series more impressed; tip of elytra with sharper angles.

G. oceanicus Rég.

This species was not included in the material received. Known by Régimbart from the Philippine Islands and from Borneo.

a². Surface of elytra and of prothorax with hairs on lateral portion.

Orectochilus.

b¹. Prothorax and elytra without a yellow margin. Length, 6.5 to 7.5 millimeters, oval; the smooth part of elytra covers about half the length and is extended into a small point reaching backward about to two-thirds the length of elytra. Exterior apical angle of elytra not pointed *O. palawanensis* Rég.

SOUTHERN PALAWAN (*Staudinger*). NORTHERN PALAWAN, Binaluan, November and December, 1913 (*Boettcher*).

b². Prothorax and elytra with a yellow margin.

c¹. Apical angles of elytra exteriorly without a pronounced spine. Ovate.

d¹. The smooth part of the elytra extends backward at the most as far as about two-thirds and is nearly rounded behind. Large species, 7.5 to 8.5 millimeters long, the description of which is given at the end of this paper *O. schultzei* sp. nov.

LUZON, Mountain Province, Benguet, Trinidad, types (*C. S. Banks*); Baguio (*Baker*): Nueva Vizcaya Province, Imugan (*Staudinger*).

The material received from Staudinger contained several specimens of a variety which differs from the typical individuals by its smaller size (6.5 to 7 millimeters), being moreover less vaulted in the scutellar region and less convex in the humeral part. The smooth part on the elytra is less regularly rounded behind, but a little heart-shaped with evidently concave sides posteriorly. There is no specific distinction from the typical individuals, but the difference is considerable on first view *O. s. var. minor* var. nov.

LUZON, Mountain Province, Butac (*Staudinger*).

d². The smooth part of elytra covers about three-fourths of the length, reaching suture behind in an angle of about 45°; 6.5 to 7 millimeters long, anterior legs small *O. oberthüri* Rég.

LUZON, Rizal Province, Montalban (*C. S. Banks*); Montalban (*Staudinger*): Camarines Sur Province, Mount Isarog, 32 specimens (*Staudinger*). Already mentioned by Régimbart from Manila and Mindanao.

Several specimens are remarkable by their small size (only 5.5 to 6 millimeters), but do not differ in any manner from the typical form.

LUZON, Mountain Province, Butac (*Staudinger*).

- d³. The smooth part of the elytra covers about six-sevenths of the length, quite rounded behind; 4 to 4.75 millimeters long.

O. pulchellus Rég.

LUZON, Nueva Vizcaya Province, Imugan (*Staudinger*): Mountain Province, Butac (*Staudinger*): Laguna Province, Los Baños (*Staudinger*): Rizal Province, Montalban (*Villegas, Staudinger*): Camarines Sur Province, Mount Isarog (*Staudinger*): Nueva Ecija, Santor (*W. Schultze*). MINDANAO, Bukidnon Province, Tangkulan (*W. Schultze, Staudinger*): Surigao (*Baker*): Zamboanga (*T. C. Zschokke*).

Several specimens of this apparently very common species differ by the hairy portion of the elytra which is anteriorly somewhat smaller, the smooth part being consequently somewhat enlarged in this region; but no further distinction is found.

- c². Apical angles of elytra exteriorly rather prominent, nearly spined.

- d⁴. The smooth part of elytra covers about three-fourths of the length and is pointed at the end. Elytra sculptured with little oblique striolæ; 5 to 6 millimeters long. *O. discus* Aubé.

LUZON, Bataan Province, Lamao (*Staudinger*): Nueva Vizcaya Province, Imugan (*Staudinger*): Laguna Province, Paete (*Staudinger*): Mount Maquiling (*Villegas, Baker*): Los Baños (*Staudinger*): Rizal Province, Montalban (*Staudinger, Villegas*): Mountain Province, Butac (*Staudinger*): Irisan (*Schultze*): Camarines Sur Province, Mount Isarog (*Staudinger*). MINDANAO, Bukidnon Province, Tangkulan (*Baker*). NEGROS, Occidental Negros Province (*C. S. Banks*).

The great variability of this species, as mentioned by Régimbart, was also evident in the material at my disposal. There are differences in shape, which is mostly attenuated to the posterior, but sometimes nearly regularly oval, and moreover in the form of the smooth part on the elytra, the extension of which is subject to considerable variation. The apical angle of the elytra may be more or less spinous, but in all cases the striolæ on the elytra are to be noted.

Some specimens from Paete differ especially by their very short-oval and very convex shape, the smooth part of the elytra being nearly oval behind and reaching rather far to the posterior. There are however no other specific differences, some of the specimens even passing over to the typical form.

The specimens from Mount Maquiling received from Mr. Baker show on the elytra on the lateral hairy portion a number of little tubular formations of about 0.1 millimeter in length, ampliate to the top, somewhat contracted just before the latter. In form they remind one of the *Hydra*, and I should be inclined to suppose them to be related; it remains however to examine the particulars of these formations.

d². The smooth part of the elytra reaches backward nearly to sutural angle. Large species, 7 to 8 millimeters in length, the description of which follows below. Attenuated to both ends, elongate, without striolæ on elytra *O. bakeri* sp. nov.

MINDANAO, Bukidnon Province, Tangkulan (*Baker*).

c². Apical angle of elytra exteriorly with a very pronounced spine; elongate-oval, elytra with oblique striolæ.

d¹. Length, 5.5 to 6 millimeters; the smooth part of the elytra reaches about three-fourths of the length..... *O. baeri* Rég.

LUZON, Laguna Province (*E. D. Merrill*). Described by Ré-

gimbart from specimens from Manila (*Baer*).

d². Length, 4.5 to 5 millimeters; very similar to the former and probably its nearest ally. Smaller, dark without the metallic hue of the preceding. The hairs on the lateral portion of elytra are whitish, while in *O. baeri* they are golden.

O. acuductus Rég.

BALABAC (*Staudinger*).

Orectochilus schultzei sp. nov.

Long. 7.5 ad 8.5 mm. (ano excepto), ovatus, convexus, ad humeros inflatus, postice leviter attenuatus. Supra nigro-olivaceus, nitidissimus, in pronoto elytris anguste ferrugineo marginatus; subtus nigro-ferrugineus, abdomine pedibusque rufis, epipleuris flavis. Capite subtilissime reticulato, labro transverso, antice modice rotundato, punctato, ciliis flavis brevibus antice longioribus instructo. Pronoto vix visibiliter reticulato, multo latius antice quam postice ad latera punctato-tomentoso. In elytris margine tomentoso ad humeros parum lato, postice latissimo, suturam ad tertiam partem attingente; spatio scutellari laevi, late ovali, postice vix acuminato; truncatura fere recta, angulo externo recto vix prominulo, interno recto. Tibiis anterioribus sat robustis et latis, ad basin breviter attenuatis, fere recte truncatis, angulo externo fere recto; tarso apud ♂ tibia paulo angustiore, apud ♀ multo angustiore.

LUZON, Mountain Province, Benguet, Trinidad, types; 2 males and 2 females in my collection and in the collection of the Bureau of Science, Manila.

Gratefully dedicated to Mr. W. Schultze, Manila.

Orectochilus bakeri sp. nov.

Long. 7 ad 8 mm. (ano excepto), ovatus, elongatus, antice et postice sat attenuatus, valde convexus. Supra niger, nitidissimus, flavo limbatus; infraniger, ano pedibusque natatoribus ferrugatis, epipleuris flavis. Capite magno, antice subtilissime reticulato. Labro fere semicirculari, punctato, ciliis brevibus flavis antice longioribus instructo. Prothoracis margine tomen-

toso parum lato, antice latiore, elytrorum ad humeros eadem latitudine, post humeros diminuat et de unde fere ad suturae apicem oblique et undulatim dilatato; spatio suturali postice evidenter acuminato, apicem versus tenuiter reticulato, in regione scutellari laevi; truncatura leviter obliqua et sinuata, angulo externo acuto, breviter spinoso, interno recto. Tibiis anterioribus rectis sat latis, ad basin attenuatis, postea subparallelis, fere recte truncatis, angulo externo paulatim rotundato; tarso apud ♂ sat lato, ad apicem attenuato, apud ♀ multo angustiore et subparallelo.

MINDANAO, Bukidnon Province, Tangkulan, types (*Baker*); 3 males, 1 female in my collection; further specimens in the collection of Prof. C. F. Baker, to whom I gratefully dedicate this species.

THREE NEW CICINDELIDÆ FROM THE PHILIPPINES

By WALTHER HORN

Berlin-Dahlem, Germany

Cicindela dilatotarsa sp. nov.

C. spinolai Gestro affinis, differt imprimis ♂ 3 primis tarsorum anticorum articulis cyaneis et multo magis dilatatis (praesertim tertio); elytrorum margine (praesertim pone medium) etiam paullo magis declivi puncto albescente antico discoidali deficiente, macula ante-apicali striolam tenuem postice paullulum incrassatam usque ad angulum suturalem emittente. Postico femorum 4 anteriorum margine pilis longissimis tenuibus ornato. Long. 7 mm. (sine labro).

LUZON bor. (coll. collectione *Ehlers-van de Poll*), 1. ♂.

The only specimen is unfortunately in very bad condition, as the antennæ, middle tarsi, and tibiæ and tarsi of the hind legs are missing. At first view the species reminds one of *C. spinolai*, which shows relatively less prominent eyes, the prothorax a little stouter, and the declivity of the border of the elytra as well as their punctation a little more developed than usual for the species. Labrum, palpi, coloration, and pubescence of body as in the latter. Middle part of metasternum with a fine sparse pilosity. The four anterior femora show a row of very long and very fine bristles on their hind border, whereas in *C. spinolai* these bristles are much shorter on the front femora and quite missing on the middle femora. The difference in the anterior tarsus is very remarkable: the first three parts in the male of *C. spinolai* are long and cylindrical, while they are large and flattened in the new species, the third part being especially broad and flat!

Cicindela microcephala sp. nov.

Ad sectionem VII, 2 (*C. virginea* et *simulatrix*) pertinens; differt ab utraque palpis paullo longioribus magisque tenuibus, capite perparvo, oculis multo minus prominentibus, orbitis subtilius striolatis; prothorace brevior; elytris paullo brevioribus, convexioribus, praesertim apicem versus evidenter declivibus, ad basim ipsam non politis, coeruleis submicantibus, minus velu-

tinis (ut sculptura paullo magis appareat), spina suturali brevior, margine apicali ante spinam suturalem minus angulato-rotundato, plaga ♀ prope suturam in quarta parte antica subnitente. Long. 9 mm. (sine labro).

MINDANAO, Surigao (*C. F. Baker*), 1 ♀.

This species resembles *C. virginea* subsp. *interposita*, but, besides the above-stated differences, differs by the more nearly parallel elytra with the apex more shortly rounded, the naked episterna of the prosternum, etc. The labrum is short and metallic, its medial bristles quite removed from the anterior margin; pronotum naked, very convex, quite smooth; elytra convex and, as regards the posterior declivity and the formation of the apex, resembling *C. clara* Schaum. The first two abdominal ventrites naked, the others laterally with white bristles of medium length and a very fine and minute pilosity on their disks. The hooked hairs on the femora fine but distinct.

Prothyma discrete-punctata sp. nov.

P. hopkinsi affinis, differt tota corporis superficie multo magis splendente ("polita," ut ita discam), capite crassiore, orbitis magis prominentibus, frontis sculptura magis levigata (striis grossis juxta-orbitalibus exceptis), disco fere nigricante, plagis viridibus et cyanescentibus deficientibus. Pronoto aureo-cuprascente politissima, convexiore, paullo longiore, levius sculpto, colorationibus viridi-cyaneis et in sulcis et episterna versus fere totis deficientibus. Elytris purpureo-cupronigricantibus, convexioribus, multo minus dense leviusque sculptis; punctis in dimidia parte antica insculptis, evidenter distantibus, postea hinc inde singulis inter se attingentibus (sed rugis deficientibus): impressionibus 5 ornatis; 1a posthumerali, 2a ad suturam in quarta parte antica posita, 3a ante maculam mediam marginalem, 4a (leviore) ad marginem anticum internum maculae apicalis, 5a ante apicem collocata; maculis 3 rotundatis albescentibus inter se aequalibus, duabus posticis aequaliter a margine distantibus (fere ut in *P. schultzei*); paullo magis a margine distante quam macula apicali *P. hopkinsi*. Femoribus totis rufo-testaceis. Long. 12 ad 14 mm. (sine labro).

SIBUYAN (*C. F. Baker*), ♀ ♂.

The form of the labrum, palpi, and penis is about the same as in *P. hopkinsi*, from which it differs at first view by the almost "polished" appearance of the whole upper side of the body, where almost all greenish and cyaneous colorations are missing; the head is larger, the eyes are more prominent, and

the prothorax is more convex; front and pronotum with smoother sculpture (excepting the rough juxtaorbital striæ). The elytra are more convex and show five more or less developed impressions and with the punctures much less closely set and less deep, even evidently less deep and less dense than in *P. schultzei*, which species resembles the new species a little in coloration and by the formation of the five impressions of the elytra; but *P. schultzei* has the last impressions much longer and more flattened (especially toward the apex!) and has the whole posterior part of the penis longer and narrower, while the new species has the bulky penis of *P. hopkinsi*. The most remarkable feature of the new species is the sculpture of the anterior half of the elytra, where the single punctures are quite flat and far removed one from the other.

REMARKS ON THE TETTIGOMETRIDÆ (FULGOROIDEA)

By C. F. BAKER

Dean, College of Agriculture, University of the Philippines

ONE PLATE

Among the Fulgoroidea no family is more isolated and peculiar than the Tettigometridæ.¹ The strongly jassoid aspect, the entirely unarmed hind tibiæ, the ocelli placed not beneath the eyes but approximate to the inner apical angle of eyes and usually mesad of the inner margin, the highly modified second antennal joint, broad propleuræ, very large tegulæ, with other characters of head, tarsi, tegmina, and apparently also of genitalia, combine to give these insects a most distinctive appearance and character.

A few species live in ant nests. More live on plants in an ordinary way, and some are of economic importance. *Tettigometra* (sens. lat.) is confined to Europe, North Africa, and western and northern Asia. Other genera are distributed through South and Central Africa, and Indo-Malayan regions. Only one of these extra-European genera (*Isthmia* || = *Hilda*) was known at the time of Signoret's review in 1865² or of Fieber's review in 1876.³ The old genus *Tettigometra* Latr. gradually became highly heterogeneous through the addition of very diverse forms. Signoret defined subgenera which may not all represent natural groups, though they appear mostly to represent distinct genera. I am not acquainted with any attempt thoroughly to systematize the group on the basis of the anatomy in general. Certain it is that such species as *brunnea* Sign., *impressifrons* M. R., *longiceps* Sign., and *lucida* Sign., are not congeneric with *obliqua* Panz., the type of the genus *Tettigometra*.

¹ A complete bibliographic history of the family was given by Horvath, *Ann. Mus. Nat. Hung.* 9 (1911) 32.

² *Ann. Soc. Ent. Fr.* 6 (1866) 139 et seq.

³ *Rev. Mag. Zool.* (1876) 111-153.

In all Tettigometridae known to me the outer basal margins of tegmina are strongly deflexed and retracted beyond the subcostal vein, the actual costal margin at base not being visible from above. There are thus formed very distinct and characteristic epipleuræ which vary in shape in the different species and genera, and which may extend to nearly half the length of the tegmina.

The following synopsis represents merely a tentative review, and indicates clearly the great need of thorough revisional work. It serves to show the general relations of Indo-Malayan forms within the family.

Synopsis of subfamilies of Tettigometridæ.

- a*¹. Vertex always broader between eyes than long; face medially plane or protuberant; head distinctly narrower than pronotum.
- b*¹. Antennal second joint not extending beyond eyes (dorsal view); head but little narrower than pronotum; outer posterior angles of eyes (dorsal view) not touching pronotum, being separated by the thickened posterior margin of vertex which extends (postocular process) more or less beyond eye laterally; face nearly plane (in profile) *Tettigometrinæ*.
- b*². Antennal second joint extending strongly beyond eyes in dorsal view; head conspicuously narrower than pronotum; outer posterior angles of eyes (dorsal view) touching pronotum; face umbonate or more or less angulate at middle (in profile) *Egropinæ*.
- a*². Vertex longer than broad between eyes and narrowly acute apically; face medially depressed; head nearly as wide as pronotum. *Megaloplastinxinæ*.

TETTIGOMETRINÆ

*Synopsis of genera of the subfamily Tettigometrinæ.*⁴

- a*¹. Postocular callosities not or very slightly extended laterally beyond eyes; outer margins of tegmina in repose, more or less distinctly converging caudad.
- b*¹. Head large, long triangular, its length subequalling half breadth, longer than pronotum, its greatest width about five-sixths that of pronotum; mesonotum far shorter than head and pronotum together; antenniferous tubercles very strongly developed; eyes small, not prominent (fide Signoret) *Mitricephalus* Signoret.
(Type, *longiceps* Sign.)
- b*². Head small and subangular anteriorly or broad, short, and broadly arcuate anteriorly; mesonotum always distinctly longer than head and pronotum together.
- c*¹. Head subangulate anteriorly between eyes, distinctly longer at middle than eyes, its width not more than three-fourths that of pronotum, usually less; lateral margins of vertex distinctly ex-

⁴This purely tentative synopsis does not include *Eurychilella* or *Eurychilopterella* of Reuter, the descriptions of which are not available to me.

tended in front of eyes; pronotum distinctly emarginate or incurved at base (fide Signoret)..... *Tettigometra* Latreille.

(Type, *obliqua* Panz.)

- c². Head broadly and evenly arcuate anteriorly between eyes, length at middle little greater than at eyes, its width about nine-tenths that of pronotum; general form narrowly ovate, the outer tegminal margins broadly outcurved; pronotum subtruncate at base (fide Signoret)..... *Brachycephalus* Signoret.

(Type, *lucida* Sign.)

- a². Postocular callosities very strongly developed, extending beyond eyes a distance nearly equaling width of eyes; anteocular margins of vertex bulging beyond outer line of eyes, the eyes thus appearing very deep set (dorsal view); vertex very broadly and evenly arcuate between eyes; fore and hind margins of pronotum subparallel, the basal margin thus strongly incurved; costal borders of tegmina reflexed, the outer margins (in repose) slightly divergent caudad.

Eurychila Signoret.

(Type, *decorata* Sign.)

EGROPINÆ

A study of much Indo-Malayan material in this subfamily has convinced me that the Asiatic congeries is distinct from the African *Isthmia* Walker (|| = *Hilda* Kirkaldy) and that Melichar was entirely justified in describing the genus *Egropa*. *Hilda* is much more similar to true *Tettigometra* in body form. *Isthmia balteata* Distant⁵ does not appear to belong to this subfamily, but to *Tettigometrinæ*, and probably with *Tettigometra tafratensis* Bergevin⁶ constitutes a distinct generic group. All African species need careful reëxamination as to anatomical details. To the list of African species should be added *Hilda welwitschi* from Angola, described by Distant.⁷

Synopsis of genera of the subfamily Egropinæ.

- a¹. Legs short; in dorsal view, antennæ surpassing eyes by less than eye width; width of head more than two-thirds width of pronotum.

- b¹. Body slender, lateral margins of closed tegmina somewhat converging caudad as in typical *Tettigometra*; vertex as long as or longer than pronotum, anteriorly rather strongly angulate between eyes. Africa *Hilda* Kirkaldy.

(= *Isthmia* Walker, type *undata* Walker.)

- b². Body very broad and stout; lateral margins of closed tegmina subparallel; vertex distinctly shorter than pronotum, anteriorly broadly arcuate, not more than slightly obtuse angulate medially between eyes. Indo-Malayan..... *Egropa* Melichar.

(Type, *inusta* Mel.)

⁵ *Insecta Transvaal*. 8 (1907) 201.

⁶ *Bull. Soc. Hist. Nat. Afr. Nord*. No. 7 11 (1920) 102.

⁷ *Ann. Mag. Nat. Hist.* 20 (1917) 186.

- a². Legs very long and slender; in dorsal view, antennæ surpassing eyes by more than twice eye width; width of head about two-thirds width of pronotum..... *Mesegropa* g. nov.
(Type, *sumatrensis* sp. nov.)

Genus EGROPA Melichar

This genus is exceedingly homogeneous throughout its range in the Orient. Even the arrangement of its very beautiful color pattern is closely similar through all of the species. There may be a high degree of sexual dimorphism, either in color or structure or both, and there is usually a high degree of variation in shades of color. Distant's color descriptions, without even sex being stated, have made it very difficult to do anything more with Indo-Malayan species until the types have been reexamined.

The species from West China, described by Melichar⁸ as *Isthmia fusca*, was referred to the Tettigometrinæ by Haupt.⁹

In all *Egropa* the tegmina are thick and coriaceous with obscured venation. There are usually three quite distinctly raised, bullate, more or less vitreous areas, a large one at base of corium, another just apicad of the middle of the transverse band which it sometimes invades, and a small one just beyond apex of clavus; the entire apical area beyond level of point of clavus is strongly convex and more or less vitreous.

Synopsis of species of Egropa Melichar.

- a¹. Vertex relatively shorter and more broadly arcuate, and little deflected; umbo very obtuse angulately prominent (in profile).
b¹. Face basally pale, unicolorous, without black markings; umbo far from apex of vertex, the basal area of face thus nearly as long as wide, the lower area (in profile) nearly parallel to vertex (fide Melichar)..... *E. inusta* Melichar.
b². Face basally black or black marked, this area apically pale margined, or all below pale; umbo proportionally nearer to apex of vertex.
c¹. Legs largely piceous; face with basal area entirely black, beyond chocolate brown..... *E. davaoensis* sp. nov.
c². Legs pale ochraceous; face pale ochraceous with three large sub-quadrangle black spots at base in both sexes.
d¹. Large, length 5.5 millimeters; inner apical area of tegmina with a row of small ocellate spots, at least in male.
E. tenasserimensis Distant.

⁸ Ann. Mus. Zool. St. Petersburg, 7 (1902) 20.

⁹ Wiener Ent. Zeits. 36 (1917) 262.

- d*². Small, length 4 millimeters; inner apical area without ocellate spots in either sex..... *E. fici* sp. nov.
- a*¹. Vertex relatively longer, obtusely subangulate between eyes, and more or less strongly deflected; facial umbo usually strongly angulate and sometimes produced.
- b*¹. Facial umbo of female similar to that of male, more or less acute angled (in profile).
- c*¹. Basal area of face clear black or piceous in male, ochraceous in female with three large subquadrate black spots; face below umbo pale, unicolorous..... *E. breviceps* Stål.
- c*². Basal area of face black in both sexes, with two or four small subcircular pale spots, the black area apically with a conspicuous pale border; face below umbo broadly pale banded, then black across apex..... *E. malayensis* Distant.
- b*². Facial umbo strikingly different in the sexes, in female produced to twice or more the length of that in male, and longer than distance from umbo to apex of vertex; lower part of face strongly transversely banded, whitish below umbo and black across apex; the basal black area with two small subcircular, submedian, pale spots.
E. jacobsoni Bierman.
E. bengalensis Distant.

Egropa inusta Melichar.

The original figures of this species, published by Melichar,¹⁰ are so diagrammatic that it is impossible to make exact comparisons with other Indo-Malayan species. The coloration, as described, appears to distinguish it from any other Indo-Malayan species. The species was unknown to Distant; he merely copied¹¹ the description and figure of Melichar. More material of this species is greatly needed.

Egropa davaoensis sp. nov. Plate 1, fig. 1.

Male, length, 3.5 millimeters. Vertex dark ferruginous, the anterior border and entire basal area of face blackish; anterior portion of face ferruginous, paler apically. Pronotum, mesonotum, and middle portion of clavus olive green; anterior and posterior margins of pronotum narrowly white cretaceous (easily rubbed off), and within the posterior white border narrowly blackish. Clavus ferruginous on basal area, the olive green on median area separated by a white line and sordid whitish on apical area, separated by a ferruginous line. Corium (Plate 1, fig. 1) uniformly castaneous, the triangular costal spot shining white, bordered proximad and distad by ferrugi-

¹⁰ Homop. Ceylon (1903) pl. 3, f. 13.

¹¹ Fauna Brit. Ind. Rhynch. 3 (1906) 368.

nous lines; a minute whitish costal dash halfway between this and apex; the dark bullate area beyond apex of clavus is flanked mesad by an irregular elongate white patch, and preceded near claval suture by a subquadrate dark spot. Middle third of tegmina with numerous minute white dots. Legs piceous, femora basally, tibiae apically, and tarsi ochraceous. Abdomen ochraceous, dark at apex.

Vertex (Plate 1, fig. 1, *a*) of the short broadly arcuate type, width between eyes distinctly more than twice length; surface areas within posterior lateral angles broadly raised to plane of margins, remainder depressed as usual, surface minutely irregularly wrinkled. Basal area of face minutely, uniformly, vermiculately wrinkled; the facial angle (in profile) very obtuse (Plate 1, fig. 1, *b*), upper and lower margins slightly concave.

MINDANAO, Davao Province, Davao (*Baker*).

The smallest species of the genus known to me.

Egropa tenasserimensis Distant.

Although Distant does not state the sex of the specimen described and figured¹² under this name, it seems to be a male. The row of small ocellate spots near inner apical angle of tegmen may be absent in the female of those species in which it occurs.

Egropa fici sp. nov. Plate 1, fig. 2.

Length, female, 4.5 millimeters; male, 3.5 to 3.75. The sexes are strikingly similar in coloration. Pale ochraceous, with olive greenish shadings on the pale castaneous of vertex, pronotum, mesonotum, and basal half of tegmina; basal area (Plate 1, fig. 2, *b*) with three large subquadrate black spots. Oblique white line on basal third of clavus indistinct. Costal triangular area (this bordered by triangular white stripes) broadly connected with inner pale area (Plate 1, fig. 2, *c*); basal bullate area and apical bullate area decolored and vitreous.

Vertex of the short broadly arcuate type, a little longer medially in female (Plate 1, fig. 2, *a*) than in male; in female width between eyes about equaling twice the length; surface evenly concave, minutely roughened, the median line slightly impressed apically. Basal area of face very minutely roughened, the facial angle (in profile) very obtuse, upper and lower margins slightly concave.

LUZON, Laguna Province, Mount Maquilang (*Baker*).

¹² Fauna Brit. Ind. Rhynch. 6 (1916) 106.

This species occurs occasionally in large colonies on the twigs of *Ficus ulmifolia*. It is apparently the palest-colored species in the genus, and is nearest to *E. tenasserimensis* Distant.

Egropa breviceps Stål.

Remarks on this species were presented by me in 1915.¹ After noting that the colonies of this *Egropa* were intermingled on *Anona* with colonies of *Gargara*, the wholly inexcusable error was made later of figuring the nymph of the *Gargara* for that of *Egropa*. In that paper, therefore, the description and figure of nymph should be credited to *Gargara* sp. This species is the largest and stoutest of the Philippine species.

Egropa malayensis Distant. Plate 1, fig. 3.

Of this well-marked species we have specimens from Penang from Sandakan, and from Puerto Princesa, Palawan. It is one of the most richly and intensely colored species when fresh. The facial umbo is slightly more prominent in the female than in the male (Plate 1, fig. 3, c). We have no females as long as 5 millimeters (fide Distant), the largest being 4.5 millimeters; the males, 4.25; but size varies considerably in both sexes in all of the species.

Vertex (Plate 1, fig. 3, a) of the longer, subangulate type; the width between eyes slightly less than twice length, concavity broad and shallow, minutely irregularly wrinkled. Genital segment of female apically narrowly bilobed. The small white spot on costal margin at three-fourths of terminal length is conspicuously bordered proximad with a dark ferruginous line which is indistinctly sinuately extended across disk. The large triangular costal spot (Plate 1, fig. 3, a) is purer white laterally, outside bordered with heavy ferruginous lines; on corium near apex of clavus with several dark subquadrate spots in a longitudinal row, in male only; these spots are variable and may have whitish centers.

Egropa bengalensis Distant. Plate 1, fig. 4.

Specimens taken in Calcutta and sent to me from the Indian Museum evidently belong to this species, described by Distant in 1909² and figured in 1916.³ None of the characters indicated as diagnostic in the last paragraph are really so, since

¹ Philip. Journ. Sci. § D 10 (1915) 137-140.

² Ann. Mag. Nat. Hist. 3 (1909) 41.

³ Fauna Brit. Ind. Rhyneh. 6 (1916) f. 79.

individual and sexual variation might account for all of them. Even the amount of depression and deflection of vertex has to be used with care, due to the fact that in drying the vertex frequently collapses more or less, producing very different appearances within the same species, and sometimes bringing the frontal umbo and point of sunken vertex close together. However, in a highly conspicuous and important character not mentioned by Distant, this species differs widely from all other species excepting only *E. jacobsoni*, described by Bierman¹⁶ from specimens taken at Semarang, Java, on *Cassia fistula* (E. Jacobson). Both of these species have the frontal umbo in the female (Plate 1, fig. 4, c) produced in a long porrect horn. Outside of characters variable in all species and differences due to sex, I cannot distinguish between these species as they are characterized by the authors. It seems probable that they are synonymous, but it remains actually to compare Indian and Javan material. Bierman gives what is apparently a quartering view of the female face in which the horn is more long-acute than in Calcutta specimens, though this may be a variable character. Some details of the Calcutta specimens are figured herein (Plate 1, fig. 4, a to g). The specimen figured by Distant is apparently a male. The green of pronotum and mesonotum may darken to ferruginous in old specimens as in other species, and the castaneous or ferruginous of tegmina become a rich chocolate brown. The three usual bullate areas of corium, one basal, one median, and one near apex of clavus, are blackened.

Genus MESEGROPA novum

From Mr. J. B. Corporaal comes a single specimen, taken at Medan, Sumatra, of a very extraordinary member of this subfamily, which at first sight was taken for one of the Megaloplastinxinæ. The more angulate head, the great length of second antennal joint (Plate 1, fig. 5, d), and the very long slender legs made this resemblance striking. But the head is far shorter in this form than in *Megaloplastinx* and far narrower than pronotum, the second antennal joint is longer, and the face medially umbonate as in *Egropa*.

The general form of body is that of *Egropa*, though longer. Tegmina about three times as long as wide. Forelegs (Plate 1, fig. 5, e) longer than tegmina. Second antennal joint (Plate

¹⁶ Notes Leyd. Mus. 29 (1907) 158, pl. 3, fig. 6. Apparently first noted in Entomol. Berichten, Dl. No. 34 (1907) 2, 162.

1, fig. 5, *d*) more than six times length of first and, in dorsal view, exceeding sides of head by about half entire width of head. Pronotum (Plate 1, fig. 5, *a*) very broadly sinuately arcuate anteriorly, truncate posteriorly; length of mesonotum equaling length of pronotum and vertex together. Width of head about two-thirds that of pronotum. Frontoclypeal suture (Plate 1, fig. 5, *c*) very strongly arcuate and deeply impressed; loræ transverse, very strongly swollen in direct facial view, appearing to extend beyond lateral margins of genæ. Lower area of front strongly transversely wrinkled.

Mesegropa sumatrensis sp. nov. Plate 1, fig. 5.

Male, length, 6.5 millimeters. Ochraceous; legs, lower part of face, and apex of abdomen piceous; vertex infuscated. Pronotum bordered anteriorly and posteriorly with fuscous, the extreme hind margin white. Mesonotum greenish ochraceous (probably olive green when fresh). Tegmina castaneous with dark fuscous shadings; the broad median transverse whitish band is almost equally triangularly expanded on commissure and costa, bordered with dark chocolate brown; basal forber of clavus, outer half of basal bulla (inner half whitish), and a broad area extending mesad from beyond apex of clavus blackened. Apices of tegmina broadly ochraceous.

Vertex (Plate 1, fig. 5, *a*) strongly angulate anteriorly, its length three-fourths of width between the middle of eyes, strongly concave, surface finely obliquely wrinkled. Upper part of face and pronotum very finely irregularly roughened.

SUMATRA, Medan (*Corporaal*).

MEGALOPLASTINXINÆ¹⁷

Synopsis of genera of the subfamily Megaloplastinxinæ.

*a*¹. Legs elongate; fore femora and tibiæ subequal; lateral carinæ of vertex more or less laminately raised.

*b*¹. Basal margin of pronotum arcuate caudad; clypeus and front (in profile) nearly in same plane, the latter oblique; second antennal joint six times as long as first..... *Megaloplastinx* Schmidt.

*b*². Basal margin of pronotum somewhat incurved; clypeus (in profile) forming a reëntering right angle (nearly) with front; the latter nearly horizontal; second antennal joint four times as long as first *Euphyonarthex* Schmidt.

*a*². Legs "somewhat short and strong"..... *Tembandumba* Distant.¹⁸

¹⁷ Schmidt, Deutsch. Ent. Zeits. (1912) 459.

¹⁸ Distant, Ann. Mag. Nat. Hist. 20 (1917) 186. In describing this genus Distant does not mention its evident relationships with Schmidt's genera, but says "Allied to *Hilda*."

ILLUSTRATION

PLATE 1

- FIG. 1. *Egropa davaoensis* sp. nov.; *a*, vertex, pronotum, and mesonotum; *b*, side view of head; *c*, tegmen, showing outlines of markings.
2. *Egropa fici* sp. nov.; *a*, vertex, pronotum, and mesonotum; *b*, basal part of face, axial view; *c*, tegmen, showing outlines of markings.
3. *Egropa malayensis* Distant; *a*, vertex, pronotum, and mesonotum; *b*, basal area of face, axial view; *c*, side view of head; *d*, female genitalia; *e*, tegmen, showing outlines of markings.
4. *Egropa bengalensis* Distant; *a*, vertex, pronotum, and mesonotum; *b*, basal area of face, axial view; *c*, side view of female head; *d*, side view of male head; *e*, male genitalia; *f*, female genitalia; *g*, tegmen, showing outlines of markings.
5. *Mesegropa sumatrensis* sp. nov.; *a*, vertex and pronotum; *b*, side view of head; *c*, clypeus, loræ, and rostrum; *d*, antenna; *e*, foreleg; *f*, male genitalia, the hooked gonapophyses pulled out from under plates.

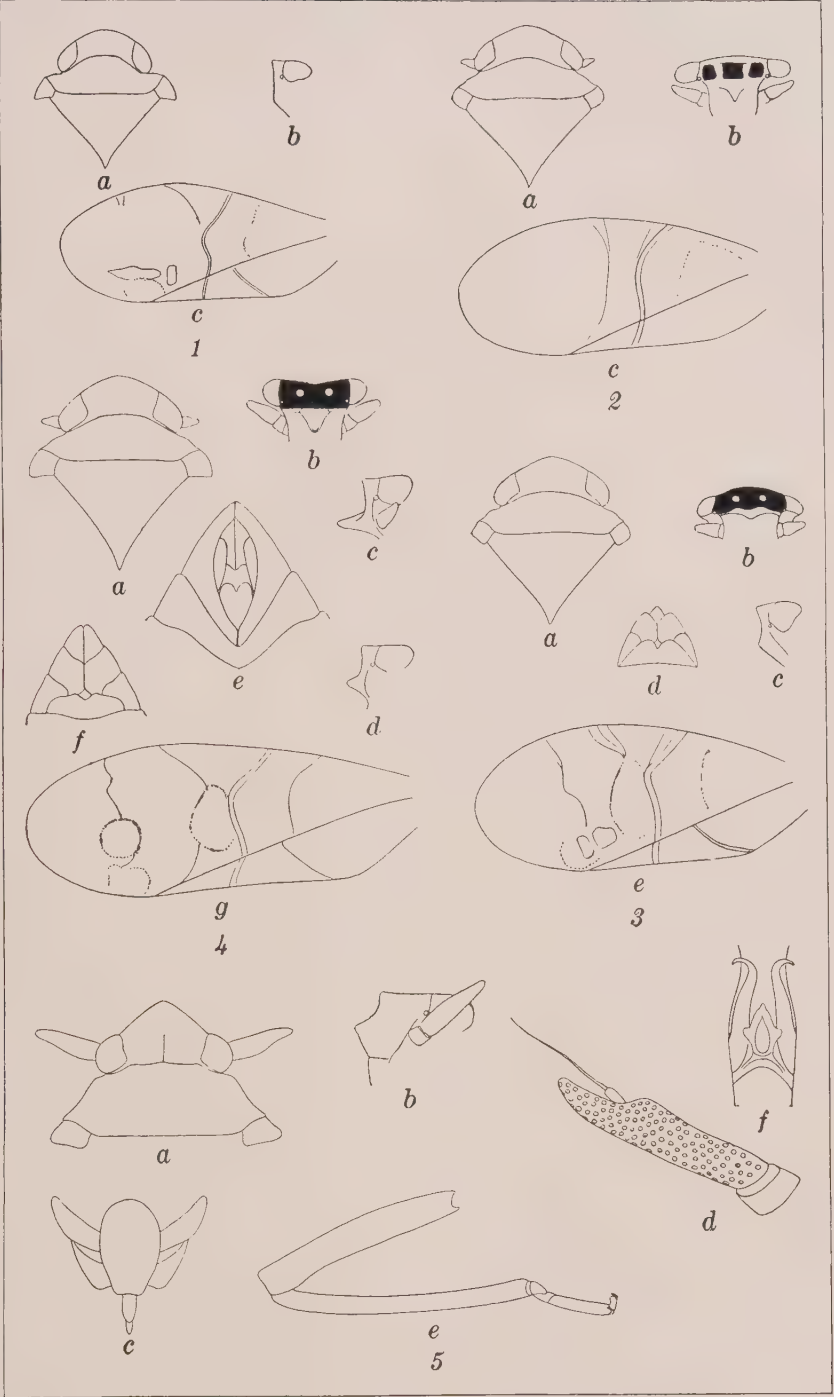


PLATE 1.

EINE NEUE PHILIPPINISCHE EUCHLORA-ART (COLEOPTERA-RUTELIDÆ)

Von FR. OHAUS

Mainz, Germany

EINE TEXTFIGUR

Euchlora cupriventris sp. nov.

Magnitudine et statura *E. smaragdinae*, supra saturate viridigraminea, polita, subtus cum pygidio laeta cuprea, polita, medio pectore, tibiis partim et tarsis viridi-aeneis; supra cum pygidio glabra, subtus pectore sparsim griseo-pilosa. Long, 21-23 mm.

♂ ♀.

NORTHWESTERN PANAY (*Baker*).

Die typischen Stücke befinden sich in der Sammlung von Professor Baker und in der meinigen.

Von allen anderen philippinischen *Euchlora*-Arten sofort zu unterscheiden durch die fast gras- oder laubgrüne, glänzend polierte Oberseite und das einfarbige, glänzend kupferrote Pygidium. Bei den zwei vorliegenden ♂♂ sind die Deckflügel ein wenig heller als der Vorderkörper, bei dem einzelnen ♀ die ganze Oberseite gleichmässig grün, die Basis des Thorax und die Spitze des Schildchens ganz



FIG. 1. *Euchlora cupriventris* sp. nov.
Forceps.

fein kupferig gesäumt; beim ♀ ist die ganze Unterseite und die Beine gleichmässig kupferrot (wie bei *cupripes* Hope) nur die Schienen und Tarsen mit erzgrünen Lichtern; beim ♂ sind die letzteren und die Mitte des Metasternums deutlicher erzgrün. Die Punktierung ist oben überall sehr fein, auf der Afterdecke ebenso auf der Scheibe, nur die Seiten und Spitze sind dicht nadelrissig.

Am Forceps, Figur 1, sind die etwas asymmetrischen Parameren an der Spitze fast rechtwinkelig nach unten gebogen; die Ventralplatte des Mittelstückes ist ähnlich wie bei der *trigonopyga*, die lappenförmige Spitze jedoch tief ausgerandet.

ILLUSTRATION

TEXTFIGUR 1. *Euchlora cupriventris* sp. nov. Forceps.

SOME RARE PHILIPPINE EELS

By ALBERT W. C. T. HERRE

Chief, Division of Fisheries, Bureau of Science, Manila

As stated in my paper on Philippine eels,¹ further collections will greatly increase our knowledge of the apodal fishes of the Archipelago. In the present paper I describe five species which came to hand after my previous article had been sent to the printer, three of which are new to the Philippines.

Genus *CÆCULA* Vahl

Key to the Philippine species of Cæcula.

- a*¹. Origin of dorsal above or not far behind gill openings.
 - b*¹. Depth 25 to 30 times in length; origin of dorsal one-fourth the length of head behind gill openings..... *C. mindora*.
 - b*². Depth 18 times in length; origin of dorsal above or very near to gill openings *C. taylori*.
- a*². Origin of dorsal more than half the length of head behind gill openings; depth 45 times in length..... *C. kaupi*.

Caecula kaupi (Bleeker).

Sphagebranchus kaupi BLEEKER, Act. Soc. Sc. Indo-Neerl., 5
Twaalfde Bijdr. Celebes 3 (1858-59); Atlas Ichth. 4 (1864) 70, pl.
157, fig. 1; WEBER and BEAUFORT, Fishes Indo-Austr. Arch. 3
(1916) 325.

Depth 45 times, the head 15.5 times in length and 6.5 times in trunk; tail a little longer than head and trunk together; eyes 13 times in head and twice in the small, sharp-pointed snout which is contained 6.5 times in head; mouth wide, 3.7 times in head, lower jaw thin and weak; teeth minute, sharp, pointed backward, in one row, the anterior ones largest; intermaxillary with a row of two similar teeth; a row of eight small teeth on vomer; vertical fins very low, origin of dorsal a little more than 0.8 the length of head behind gill openings; both dorsal and anal expanded near tip of tail, as shown in Bleeker's figure.

The ground color, in an alcoholic specimen, is pale yellow; this is densely punctulated on sides and above with dark dots so that the back is dark olive, which gradually fades out low

¹ Philip. Journ. Sci. 23 (1923) 123-236.

down on the sides; fins concolorous; a row of light spots along the lateral line.

Here described from a specimen, 405 millimeters long, collected by E. H. Taylor about 5 kilometers from the sea in Graan River, on the southern coast of Cotabato Province, Mindanao. My specimen is unquestionably specifically identical with the only other specimen known, which came from a river in Celebes.

Genus *ACHIROPHICHTHYS* Bleeker

Achirophichthys BLEEKER Ned. Tijdschr. Dierk. 2 (1864) 41.

The elongate body rather stout and nearly cylindrical, tail a little longer or shorter than head and trunk together; head small or of medium size, with pointed snout and weak jaws, the lower equal to or shorter than the upper; eyes small, well forward; anterior nostrils not tubulate, but merely with a prominent rim; lips not fringed or with but one row of minute tubercular papillæ; teeth of unequal size, those on vomer wholly or partially caniniform; mandibles with a single row of teeth, and some canines anteriorly; intermaxillary plate with canines; maxillary teeth in one or two rows; no pectorals; origin of dorsal rather close to gill openings, or not more than one-third the length of head behind them; gill openings wide, low down on side.

This genus, not hitherto known from the Philippines, contains two species, one from Celebes and one from New Guinea, with but a single specimen previously recorded for each.

Achirophichthys kampeni (Weber and Beaufort).

Brachysomophis kampeni WEBER and BEAUFORT, Fishes Indo-Austr. Arch. 3 (1916) 316, figs. 150 and 151.

Depth contained about 24.7 times in length, head a trifle more than 8 times, and 2.9 in trunk; head and trunk together a tenth their own length shorter than tail; eyes small, covered with skin, more than 19 times in head and nearly 2.5 times in narrow and pointed snout; mouth large, reaching far behind eye, its gape more than 2.8 in head; a single row of slender, compressed, recurved teeth in maxillaries; a curved row of five canines around anterior margin of intermaxillary plate; three large canines on vomer, with two very small teeth between first and second and second and third, and a single small tooth behind the last one; a single row of teeth on mandible, slightly larger than those of upper jaw, those of anterior half

rather widely spaced, and with two or three pairs of canines at anterior extremity.

Trunk full and robust with head of the same character but with weak pointed jaws and snout; distance from origin of dorsal to gill openings equal to distance from posterior margin of eye to tip of snout; both dorsal and anal low, about equal in height, extending almost to tip of tail, as shown in fig. 150, cited above. Lower jaw much shorter than upper, so that the intermaxillary teeth are well forward of and overlap mandible when it is closed.

Dark olive brown above, yellow below the conspicuous lateral line, which is marked by a row of circular yellow dots. Dorsal fin dark like back, anal fin yellow like belly.

Here described from a specimen, 395 millimeters in length, obtained at Lamug, a barrio of Peñablanca, from Pinacanauan River, a small stream which flows into Cagayan River at Tuguegarao, Cagayan Province, Luzon. It must be fairly common in this region, as it seems to be known to the people, although I only succeeded in securing one specimen. Hitherto known only from a specimen, 323 millimeters long, collected in Humboldt Bay, New Guinea, and preserved in the Zoölogical Museum of Amsterdam. It differs from my example in having the head and trunk somewhat longer than the tail.

Cirrhimuræna oliveri (Seale).

In a collection of eels made by E. H. Taylor on a coral reef at Despujol, Tablas, I discovered a fine specimen of this rare little fish, hitherto known only from the type, collected by Alvin Seale at Zamboanga.

Length, 500 millimeters; depth 40 times, head 13.13 times in length and 4 times in trunk; head and trunk contained 1.63 times in the very slender elongate tail, which is 62 per. cent of total length; eyes small, 2.5 times in the narrow, convex snout, which is $6\frac{1}{3}$ times in head; mouth large, about 3 times in head; pectoral 3.45 in head; three rows of fine sharp pointed teeth on maxillaries, apically passing into a broad band of four rows on vomer; intermaxillary plate with a marginal row of thirteen teeth and a central row of four slightly longer teeth; mandibles with three rows of coarser teeth anteriorly, passing into two rows of finer teeth posteriorly; a broad toothless space at symphysis.

This very distinct species is distinguished at a glance from all other members of the genus by the origin of the dorsal, which is anterior to the gill openings by the length of the pectoral in the type, and one and a half times the length of the pectoral in the Tablas specimen.

Gymnothorax polyuranodon Bleeker.

Muraena polyuranodon BLEEKER, Nat. Tijdschr. Ned. Ind. 5 (1853) 248; WEBER and BEAUFORT, Fishes Indo-Austr. Arch. 3 (1916) 369, fig. 185.

Gymnothorax polyuranodon BLEEKER, Atlas Ichth. Muræn. 5 (1864) 89, pl. 174, fig. 2.

Among the fishes obtained by E. H. Taylor along the southern coast of Cotabato Province, Mindanao, were three specimens of this eel, hitherto unrepresented in the Bureau of Science collections. Two of them, 475 and 380 millimeters long, respectively, were from Craan River, and one, 275 millimeters long, was collected in Saub River. In each instance they were about 4 kilometers from the sea. The following description is taken from the largest specimen.

Depth 25 in total length; head 9.5 times, 4 times in trunk, and 4.5 times in tail, which is half the length of head shorter than head and trunk together; eyes about 14 times in head and twice in snout, placed about halfway between tip of snout and the angle of the wide mouth, which goes $3\frac{1}{3}$ times in head; teeth numerous, their sharp points curved backward, in two rows in maxillaries, those of the inner row larger; intermaxillary plate with two rows, the inner teeth longer, and with two longer, strongly recurved, depressible teeth in a central row; vomer with a single row of four small teeth (nine in the next larger specimen); teeth in mandible in two rows, these very close together posteriorly but wide apart and much larger anteriorly, those of the inner row very much longer and stronger.

An elongate eel with strongly compressed trunk, the tail especially so, the skin thick and leathery; snout short, narrow, jaws equal, but lower one sometimes curved so that it cannot meet upper one closely; head small, narrow, but with occipital region strongly elevated; gill openings nearly twice as large as eyes; origin of dorsal just anterior to gill openings; dorsal and anal low, little developed except on tail and nowhere conspicuous.

The color in alcohol is yellowish brown, everywhere covered with more or less rounded, often confluent and irregular black

spots; on the head they unite into more or less clearly defined narrow longitudinal bands, separated by pale longitudinal streaks of the ground color, especially well defined on the sides and throat.

A handsome and very well defined species.

Ophichthus evermanni Jordan and Richardson.

Ophichthus cephalozona variety GÜNTHER, Cat. Fishes Brit. Mus. 8 (1870) 70.

Ophichthus evermanni JORDAN and RICHARDSON, Cat. Fishes of Formosa, Memoirs Carnegie Museum 4 (1909) 172, pl. 67, upper figure.

Depth 24 times, head 9.7 times in total length; head 4.1 times in trunk, and head and trunk together longer than tail which goes 1.1 times in them; snout slightly longer than breadth of interorbital space and 5.85 times in head; the eye is 10.25 times in head and 1.75 in snout; gape 3.15 times in head, reaching well behind eyes.

Body robust, full and rounded, its transverse diameter nearly equal to its depth, the tail stout and rather blunt; snout convex, blunt, interorbital space nearly flat; eyes full, circular; pectorals broad, short, their length 4.1 in head; origin of dorsal over the middle of pectorals; four teeth, irregularly disposed on intermaxillary plate; teeth in jaws and on vomer one-rowed, pointed, curved, fixed.

Color in alcohol rich purplish brown, more or less white under head and on belly; body marked dorsally and on sides with many irregular dark brown blotches and bands which extend on to dorsal fin; there is a very large but poorly defined blackish blotch on nape; a large bluish white blotch extends up on each side from belly toward nape, partially separating it from the dark olive crown and snout; there are traces of pale patches behind the nuchal blotch also; margin of dorsal white; anal fin pale.

This handsome eel is readily separable from *O. cephalozona* and occurs from Cebu to southern Japan. It is here described from a very fine specimen, 798 millimeters in length, collected at Alaminos, Pangasinan Province, Luzon.

PLANTS FROM BANGUEY ISLAND

By ELMER D. MERRILL

Director and Botanist, Bureau of Science, Manila

Mr. D. D. Wood, conservator of forests, British North Borneo, and party made a small collection of plants on Banguey Island in October, 1922, this material apparently being the first botanical collection made on that island. Banguey is situated off the extreme northeast coast of Borneo, and forms a part of the southern boundary of Balabac Strait, separating Borneo from the Philippines; politically, it is a part of British North Borneo. The small collections available indicate that its flora is intermediate between that of the Philippine group and Borneo, but with rather more numerous Philippine elements than would be expected.

ARACEAE

AMORPHOPHALLUS RIVIERI Durieu var. *KONJAC* (C. Koch) Engl.

No. 1127, in damp alluvial soil. Japan to Indo-China and the Philippines.

PALMAE

CALAMUS JAVENSIS Blume var. *WOODII* var. nov.

Forma distincta, foliis oblongo-ellipticis, circiter 20 cm longis, 5.5 ad 7 cm latis, sessilibus, inflorescentiis ♂ laxissimis.

No. 1111, in forests, Libuak Valley. In placing this under *Calamus javensis* Blume I have followed Beccari in his very broad interpretation of Blume's species. It seems to be most closely allied to *Calamus javensis* Blume var. *peninsularis* Blume of the Malay Peninsula. Complete material may show it to be amply distinct.

ZINGIBERACEAE

COSTUS SERICEUS Blume.

No. 1108, in hilly regions. Burma to Java, the Philippines, and New Guinea. *Rintubu* (Dusun).

ORCHIDACEAE

GEODORUM NUTANS (Presl) Ames (*G. semicristatum* Lindl.).

No. 1116, Limbuak Valley at low altitudes. Common and widely distributed in the Philippines but hitherto unrecorded from outside of the Archipelago. The genus is new to Borneo.

HABENARIA HYSTRIX Ames (*H. muricata* Vidal).

No. 1117, Limbuak Valley. Widely distributed in the Philippines but hitherto unrecorded from outside of the Archipelago.

MORACEAE

ANTIARIS TOXICARIA (Pers.) Lesch.

No. 1135, in hilly regions, Limbuak Valley. India to southern China, through Malaysia to the Philippines and the Moluccas. The sap, mixed with the juice of a vine, is used for poisoning arrows. *Ipoh* (Malay), *dalit* (Dusun).

ANONACEAE

GONIOTHALAMUS WOODII Merr.

No. 1129, in forests at low altitudes. Borneo.

UVARIA MICRANTHA (DC.) Hook. f. & Th.

No. 1122, Limbuak Valley. Burma and Indo-China to Sumatra, Borneo, and the Philippines. *Tient* (Dusun).

UVARIA PURPUREA Blume.

No. 1134, without data. Southern China to the Malay Peninsula and Archipelago.

LEGUMINOSAE

ALBIZZIA RETUSA Benth. (*A. littoralis* Teysm. & Binn.).

No. 1118, along the seashore at Petongan, the bark used by the natives as a soap substitute. Nicobar Islands through Malaysia to the Carolines, but not as yet recorded from Borneo proper. *Langir kayo* (Malay).

ENTADA PHASEOLOIDES (Linn.) Merr. (*E. scandens* Benth.).

No. 1119, Limbuak Valley. Pantropic in various forms, the typical form widely distributed in Malaysia. *Baligo* (Dusun).

EUPHORBIACEAE

ANTIDESMA BANGUEYENSE sp. nov.

Arbor parva, circiter 5 m alta ramulis et subtus foliis et inflorescentiis plus minusve pubescentibus; foliis oblongis ad oblongo-ovatis, 11 ad 14 cm longis, 4 ad 5.5 cm latis, chartaceis

ad subcoriaceis, apice perspicue acuminatis apiculatisque, base obtusis ad subrotundatis, supra, costa excepta, glabris, olivaceis, nitidis, subtus pallidioribus, pubescentibus, nervis utrinque circiter 8, subadscendentibus, supra leviter impressis, subtus valde perspicuis; petiolo 4 mm longo, pubescente, stipulis anguste lanceolatis, pubescentibus, deciduis, petiolo aequantibus; infructescentiis solitariis, terminalibus vel in axillis superioribus, racemosis, 7 ad 10 cm longis, pubescentibus; floribus 5-meris, sepalis persistentibus lanceolatis, circiter 1 mm longis, pedicellis 1.5 mm longis; fructibus subovatis, obliquis, subcompressis, perspicue reticulatis, distincte ciliatis, apice obtusis, leviter oblique rostratis, basi rotundatis.

No. 1121, Limbuak Valley, at low altitudes. A species apparently belonging in the same group with the Bornean *Antidesma forworthyi* Merr., from which it differs radically in its smaller, pubescent leaves and in its pubescent fruits.

WETRIA MACROPHYLLA (Blume) J. J. Sm.

No. 1124, Limbuak Valley. Luzon, Bancalan, and Negros in the Philippines, Borneo, Sumatra, and Java. *Rambay utan* (Malay.)

VITACEAE

TETRASTIGMA LOHERI Gagnep.

No. 1128, at low altitudes in Limbuak Valley. This species is widely distributed in the Philippines, extending from northern Luzon to Palawan and Mindanao; it has hitherto not been recorded from outside of the Archipelago.

FLACOURTIACEAE

PANGIUM EDULE Reinw.

No. 1120, along the Pankulan River. Throughout Malaysia, often planted. *Rangi* (Dusun), *kapayang* (Malay).

LYTHRACEAE

LAGERSTROEMIA SPECIOSA (Linn.) Pers.

No. 1105, at low altitudes, Limbuak Valley. India to tropical Australia. *Tibaba* (Dusun).

MYRTACEAE

DECASPERMUM FRUTICOSUM Forst. (*D. paniculatum* Lindl.).

No. 1109, at low altitudes. India to tropical Australia and Polynesia.

ARALIACEAE

SCHEFFLERA INSULARUM (Seem.) Harms.

No. 1112, Limbuak Valley. Common and widely distributed in the Philippines from central Luzon to Mindanao, but not previously recorded from outside of the Archipelago.

MYRSINACEAE

DISCOCALYX PALAWANENSIS Elm.

Nos. 1125, 1130, Limbuak Valley, at low altitudes. Palawan. *Mationg* (Dusun).

EMBELIA PHILIPPINENSIS A. DC.

No. 1113, in thickets or forests at low altitudes. Widely distributed in the Philippines, but hitherto not recorded from outside of the Archipelago.

ACANTHACEAE

THUNBERGIA FRAGRANS Roxb.

No. 1110, in thickets at low altitudes. India to Australia.

RUBIACEAE

IXORA GRANDIFOLIA Zoll. & Mor.

No. 1106, Limbuak Valley, at low altitudes. The specimen is with very young buds but is probably referable here. The species is widely distributed in western Malaysia but has not been found in the Philippines.

IXORA sp.

No. 1123, with the preceding, but with fruits only.

MUSSAENDA VILLOSA Wall.

No. 1114, on hills, Limbuak Valley. The specimens are imperfect but are probably referable to Wallich's species which occurs in the Malay Peninsula. *Daliadak* (Dusun), *kinabudan* (Malay).

PETUNGA RACEMOSA (Roxb.) K. Schum.

No. 1115, at low altitudes. India to Borneo and Java, extending into the Philippines in Balabac and Palawan.

TARENNA CUMINGIANA (Vidal) Elm. Leaf. Philip. Bot. 5 (1913) 1898.

No. 1107, from low altitudes. *Ramos 1335* from British North Borneo, identified and distributed as *T. winkleri* Val., is the same. Widely distributed in the Philippines but hitherto not recorded from outside of the Archipelago. *Baguiran* (Dusun).

TAXONOMIC VALUE OF HAIR IN CHIROPTERA

By HOWARD IRVING COLE

Chemist, Bureau of Science, Manila

TWO PLATES

The hair of all the available species of Philippine bats¹ was examined microscopically, in the hope that a morphological study might bring to light characteristics of taxonomic value. The work presented here has not warranted the drawing of conclusions, as it is of a purely preliminary character; but, on the other hand, this study may prove to be suggestive, and I hope it may lead to a more complete and detailed examination of the hair of Chiroptera in its relation to taxonomy.

The hair of mammals can be broadly divided into two types; namely, the fur, or under hair, and the protective, or over hair. The former constitutes the major portion of the body covering and is ordinarily much finer and clearer than the protective hair. Hausman² has shown that the hairs of mammals differ markedly in morphologic characteristics.

In identifying hair species it is necessary to compare the scales and medulla from the same part of the hair, since the form of the scale changes from the base to the top of the hair shaft. In the examination of the hairs of the bat species enumerated below hair specimens were taken from the region of the median line of the dorsum just below, that is, caudad of the shoulders, as suggested by Hausman. The hairs were thoroughly washed in a mixture of equal parts of 95 per cent alcohol and chloroform. Difficulty in distinguishing the shape of the scales when the hair was mounted in air was overcome by staining with an alcoholic solution of gentian violet.³

¹ Twenty-four species were examined. This is somewhat less than half the number enumerated by Hollister, *Philip. Journ. Sci.* § D 7 (1912) 7.

² Hausman, L. A., *Am. Journ. Anat.* 27 (1920) 463; *Journ. Am. Mus. Nat. Hist.* 20 (1920) 434; *Am. Naturalist* 54 (1920) 509; *Scientific Monthly* 12 (1921) 215.

³ Hausman, L. A., *Am. Naturalist* 54 (1920) 519.

In order to observe the medulla the hairs were washed as before in an alcohol-chloroform mixture, then with xylol, and mounted in thin Canada balsam.

The 4 millimeters objective and the 7.5 ocular were usually used in the microscopical examination. By using reflected and transmitted light discriminately the air-mounted specimens show clearly the shape of the scales, while the balsam-mounted specimens show the medulla (when present) and the pigmentation of the cortex layer. Very few of the bat (fur) hairs contained a medulla. In fact, of those examined only the Pteropidæ and Megadermidæ showed the presence of medulla.

The systematic positions of the species of bats from which hair was examined are shown in the following list:

MEGOCHIROPTERA

PTEROPIDÆ

PTEROPINÆ

Cynopterus brachyotis (Müller).

Rousettus amplexicaudatus
(Geoffroy).

Acerdon jubatus (Eschscholtz).

Acerdon jubatus (?).

MACROGLOSSINÆ

Macroglossus lagochilus
Matschie.

Eonycteris robustus Miller.

MICROCHIROPTERA

EMBALLONURIDÆ

EMBALLONURINÆ

Taphozous philippinensis Waterhouse.

MEGADERMIDÆ

Megaderma spasma (Linnæus).

RHINOLOPHIDÆ

Rhinolophus virgo Andersen.

Rhinolophus rufus Eyndoux and
Gervais.

HIPPOSIDERIDÆ

Hipposideros diadema griseus
(Meyen).

Hipposideros pygmaeus Waterhouse.

VESPERTILLIONIDÆ

VESPERTILLIONINÆ

Myotis macrotarsus (Waterhouse).

Myotis sp.⁴

Myotis sp.⁴

Pipistrellus abramus (Temminck).

Pipistrellus sp.⁴

Scotophilus temminckii (Horsfield).

MINIOPTERINÆ

Miniopterus tristis (Waterhouse).

Miniopterus eschscholtzii (Waterhouse).

Miniopterus paululus Hollister.

KERIVOULINÆ

Kerivoula sp.⁴

MOLOSSIDÆ

Chaerophon luzonius Hollister.

⁴ This form probably represents an undescribed species.

The fur hairs of these species are illustrated in the accompanying plates. The hairs are all drawn to the same scale, 400 magnification. Each figure contains a diagram of the hair as seen in air and in balsam, to show the form of scale, the medulla, and the pigmentation.

Plate 1, figs. 1 to 7, inclusive, shows the type of fur hair common to the Pteropidæ. The cuticular scales are coronal and slightly serrated. The medulla is discontinuous, simple, and ovate.⁵ The pigmentation is finely dotted, grouped in streaks.

Plate 1, fig. 8, shows the only specimen of hair of the family Emballonuridæ. The cuticular scales are coronal and regularly serrated. There is no medulla. The pigmentation is finely dotted in short streaks.

The family Megadermidæ is represented by *Megaderma spasma*, shown in Plate 1, fig. 9. The fur hair of this species has coronal, slightly serrated cuticular scales, and a discontinuous ovate medulla. The hairs from two species of Rhinolophidæ are shown in Plate 1, figs. 10 and 11. The cuticular scales are coronal and slightly serrated. There is no medulla. The pigmentation of both species is finely dotted in longitudinal streaks.

The hairs of *Hipposideros diadema* and *H. pygmaeus* are shown in Plate 1, fig. 12, and Plate 2, fig. 13. The hairs of these two species are very similar, with coronal, simple, cuticular scales, no medulla, and finely dotted pigment grouped in longitudinal streaks.

Ten species of the family Vespertillionidæ are illustrated (Plate 2, figs. 14 to 23). The type of pigmentation varies within the family, as shown in the figures, the dots in some of the genera being grouped longitudinally and in some, transversely. The cuticular scale form and the type of pigmentation are very similar in the three species of the genus *Myotis*. This is also true for the genus *Miniopterus*. All the specimens of Vespertillionidæ, except *Scotophilus temminckii* and *Kerivoula* sp., have pigment granules grouped transversely. From the viewpoint of the type of pigmentation of the hair the genus *Scotophilus* appears to be more closely related to the genus *Kerivoula* than to *Myotis* and *Pippistrellus*.

The hair of *Chaerophon luzonus* of the Molossidæ is shown in Plate 2, fig. 24. The cuticular scales are coronal and dentated.

⁵ See Hausman's classification of hair, *Am. Naturalist* 54 (1920) 505.

There is no medulla. The cuticular scales of this hair are the most elaborate of any of those examined.

There seems to be little hope that the morphological characters of the fur hair can be used to aid in the differentiation of species of bats, but a more complete study might well lead to the use of fur hair as an added characteristic in the classification of the genera of Chiroptera. In the specimens examined the type of pigmentation and cuticular scale did not vary within the genus, but did vary within the family.

My thanks are especially due to Mr. Edward H. Taylor, who furnished the specimens of hair used in this work and whose kindly advice was invaluable to me in the preparation of this study.

ILLUSTRATIONS

Fur hairs of Chiroptera as seen under the microscope, mounted in air and in balsam; magnification, $\times 400$.

PLATE 1

- FIG. 1. *Cynopterus brachyotis*.
2. *Rousettus amplexicaudatus*.
3. *Rousettus amplexicaudatus*.
4. *Acerdon jubatus*.
5. *Acerdon jubatus* ?
6. *Macroglossus lagochilus*.
7. *Eonycteris robustus*.
8. *Taphozous philippinensis*.
9. *Megaderma spasma*.
10. *Rhinolophus virgo*.
11. *Rhinolophus rufus*.
12. *Hipposideros diadema griseus*.

PLATE 2

- FIG. 13. *Hipposideros pygmaeus*.
14. *Myotis macrotarsus*.
15. *Myotis* sp.?
16. *Myotis* sp.?
17. *Pipistrellus abramus*.
18. *Pipistrellus* sp.?
19. *Scotophilus temminckii*.
20. *Miniopterus tristis*.
21. *Miniopterus eschscholtzii*.
22. *Miniopterus paululus*.
23. *Kerivoula* sp. ?
24. *Chaerophon luzonus*.

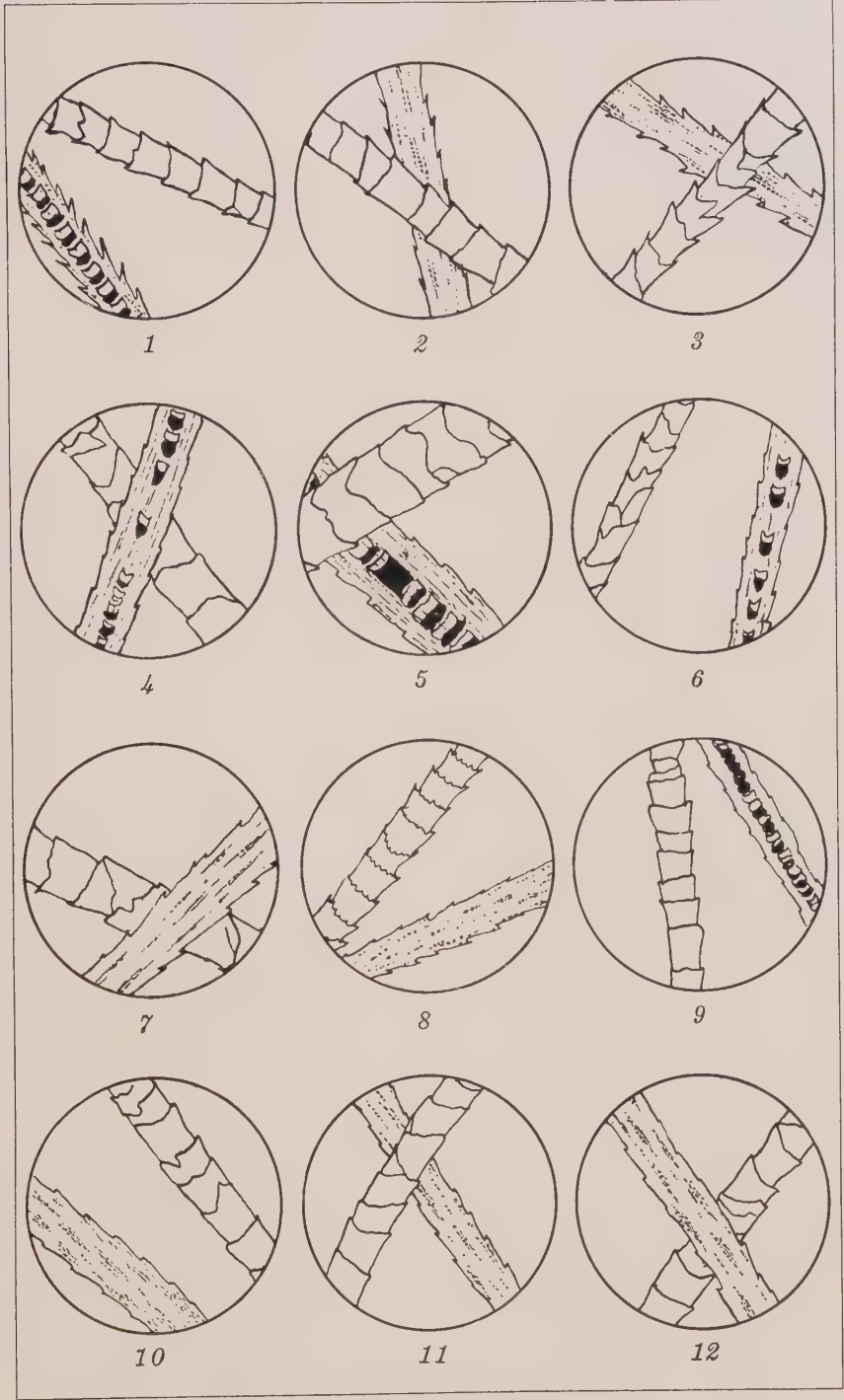


PLATE 1.

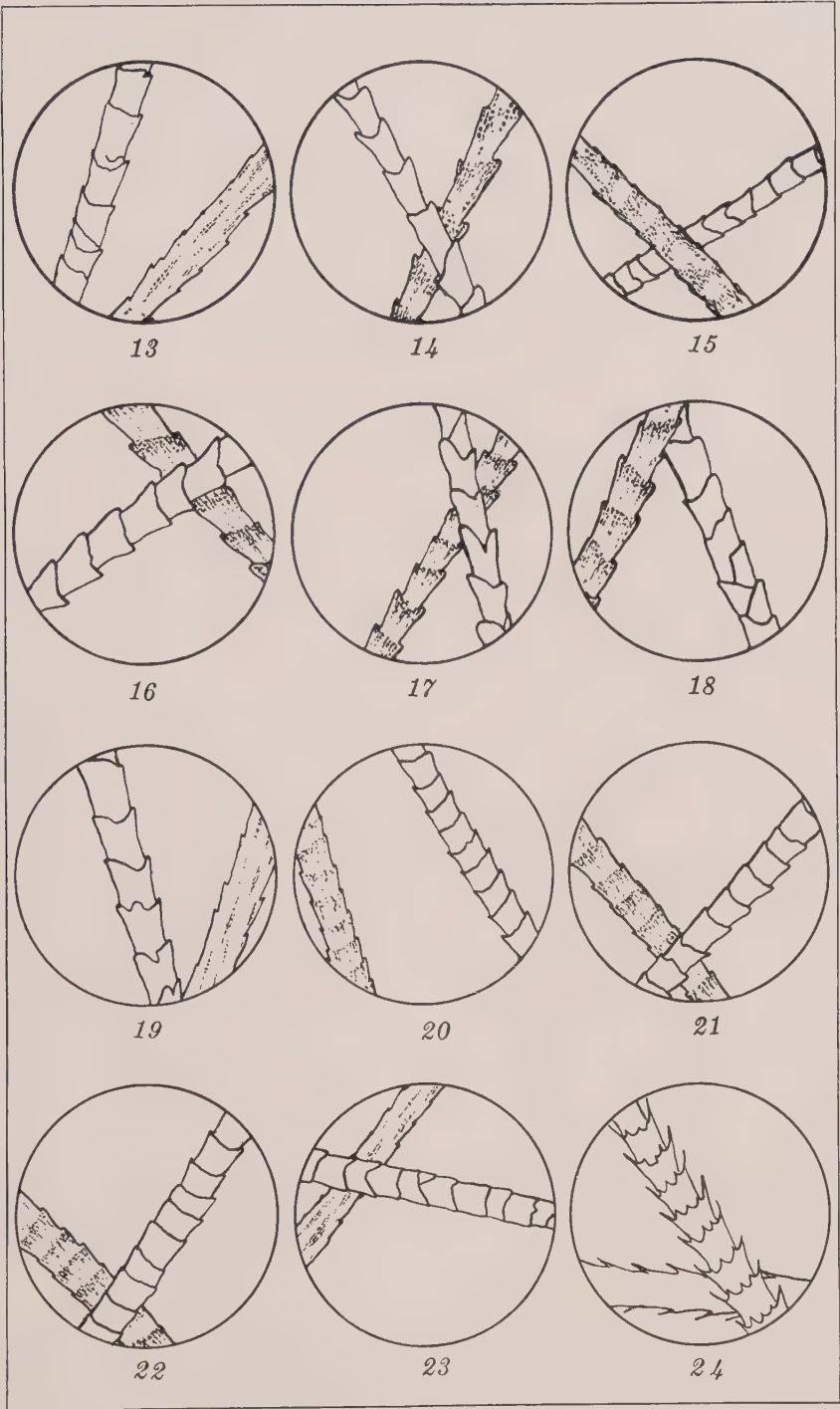


PLATE 2.

OXIDATION OF LUMBANG AND LINSEED OILS, AND OF THE PRINCIPAL COMPOUNDS IN LUMBANG OIL

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and

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ONE PLATE

INTRODUCTION

Drying oils have the characteristic property of absorbing oxygen and drying to an elastic skin when exposed in a thin layer to the air. Although a number of investigations have been carried out to ascertain the exact mechanism of the drying process, the chemical changes involved are but very imperfectly understood. Most of the important work on the drying of oils has been done with linseed, the most widely used drying oil, and brief reviews of the literature are given by Lewkowitsch, Friend, and Livache and McIntosh.¹

Lumbang (candle-nut) oil, as a drying oil, appears to be equally as good as linseed oil for the manufacture of paints, varnishes and similar products. The composition (Table 1) of lumbang oil is somewhat similar to that of linseed oil, in that both oils consist of a mixture of unsaturated glycerides (linolenic, linolic, and oleic) and contain also glycerides of saturated acids. It seemed that lumbang oil might serve as excellent material for studying the oxidation (drying) process, since it consists almost entirely of unsaturated glycerides. Moreover, as it contains a much smaller percentage of saturated glycerides than does linseed oil the approximate composition of the partially oxidized oil is more easily determined in the case of lumbang than in that of linseed oil.

¹ Lewkowitsch, J., *Chemical Technology and Analysis of Oils, Fats, and Waxes* 3 (1915) 177; Friend, J. N., *The Chemistry of Linseed Oil* (1917); Livache, Ach., and McIntosh, J. G., *The Manufacture of Varnishes and Kindred Industries* 1 (1919).

As a preliminary investigation of the chemical changes involved in the oxidation (drying) process we thought it might, perhaps, be of interest to determine the comparative oxygen absorption of lumbang and linseed oils oxidized under the same conditions. It also seemed that data obtained by analyzing samples of lumbang oil oxidized for various periods of time might be of interest in showing the relative oxidation of the principal compounds in lumbang oil.

When linseed or lumbang oil dries, oxygen of the air is not only absorbed by the oil and fixed permanently, forming a non-volatile, solid, elastic skin called linoxyn, but oxygen also reacts with the oil to form volatile products which escape in the air. The drying process tends then to separate the oil into two portions, one of which is volatile and the other nonvolatile. A thorough study of the oxidation (drying) process should include investigations of the nonvolatile portion of the oxidized oil, the volatile products, and also the quantity and rapidity of oxygen absorption.

HISTORICAL REVIEW

Researches² on blown linseed oil have shown that the volatile products consist mostly of water, carbon dioxide, formic and acetic acids, and certain aldehydes.

Although the chemistry of the nonvolatile portion of linseed oil has not been worked out in a satisfactory manner, Lewkowitsch³ states that when linseed oil dries the final product appears to be the same, whether raw linseed oil is allowed to absorb oxygen slowly from the atmosphere, the drying accelerated by previously boiling the raw oil (boiled oil), or a current of oxygen passed through the raw oil at an elevated temperature producing blown oil.

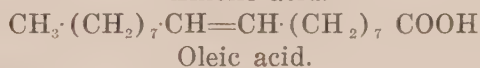
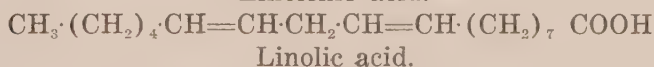
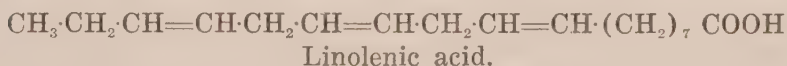
The commercial valuation of an oil suitable for the manufacture of paint and varnish depends on its drying power. This is determined principally by the time required for drying to an elastic skin. The method that has been commonly employed for determining the relative oxygen absorption, or drying power, of an oil is known as the "glass plate" method. In this method the oil is spread in a thin layer on a glass plate, exposed to the atmosphere, and the time required for drying ascertained. For comparative data duplicate tests are made with

² Friend, J. N., *The Chemistry of Linseed Oil* (1917) 50.

³ Lewkowitsch, J., *Chemical Technology and Analysis of Oils, Fats, and Waxes* 3 (1915) 177.

an oil of known quality. The method does not give absolutely accurate results since the data obtained vary with the thickness and uniformity of the oil layer, the quantity of oil used, and various other factors. Even if weighed quantities of oil are employed the increase in the weight of the oil represents only the apparent oxygen absorption and not the actual amount of absorbed oxygen since volatile products, which escape during the drying process, cause a loss in weight. Again, the "glass plate" method does not give accurate data as to the exact mechanism of the oxidation process and the composition of the oxidized oil.

As to the absorbed oxygen that is fixed permanently by the nonvolatile portion of the oxidized oil during the drying process, it seems that in some way it saturates the double bonds of the unsaturated compounds contained in the oil. The formulas that have been suggested for the unsaturated acids, which are present as glycerides in linseed and lumbang oils, are as follows:



If it is true that, in drying, the absorption of oxygen takes place at the double bonds, then linolenic glyceride, containing nine double bonds, should absorb oxygen more readily than linolic glyceride which contains six double bonds, and the latter more readily than oleic which contains only three double bonds.

A certain proportion of the oxidized glycerides, which are present in blown linseed oil, may be decomposed into their corresponding oxyacids. The latter substances, known as Fahrion's oxyacids,⁴ are characterized by their insolubility in petroleum ether. Formulas of these oxyacids have not as yet been worked out in a satisfactory manner.

Some authorities are inclined to think that, in the saturation of the double bonds, peroxides are formed and that these substances act as autocatalysts and accelerate the oxidation reaction (drying); that is, the peroxide (autocatalyst) acts as a carrier of oxygen from the air to the oil which is the acceptor (theory

⁴ Livache, Ach., and McIntosh, J. G., *The Manufacture of Varnishes and Kindred Industries* 1 (1919) 78 and 96; Lewkowitsch, J., *Chemical Technology and Analysis of Oils, Fats, and Waxes* 1 (1921) 592.

of Engler and Weissberg). According to this view the drying process is, then, an autocatalytic reaction.

The experiments of Genthe⁵ on the drying of linseed oil gave figures which seemed to correspond approximately to the equation for an autocatalytic reaction. From these results it would appear that drying is, perhaps, an autocatalytic process. Genthe was inclined to think that the autocatalyst had the character of a peroxide, though he did not isolate such a compound.

The foregoing brief discussion will, perhaps, give some idea of the more important suggestions that have been advanced to explain the peculiar property of drying which is a characteristic of vegetable drying oils.

LUMBANG OIL

In most of the oxidation experiments recorded in this paper Philippine lumbang (candle-nut) oil was used though, for comparison, some experiments were made with linseed oil. Lumbang oil is obtained from the seeds of *Aleurites moluccana*, which is a large tree reaching a diameter of 80 to 160 centimeters. *Aleurites moluccana* is fairly abundant in a wild state in many parts of the Philippines and can be grown readily in plantations. It is also distributed through Polynesia, the Malayan region, and the Hawaiian Islands.

The constants and general properties of lumbang oil have been determined by various investigators.⁶ The determination of oil constants showed that lumbang oil, like linseed, is characterized by high iodine and saponification values.

Brill and Agcaoili,⁷ and also Aguilar,⁸ carried out a few experiments to determine the drying properties of lumbang oil as compared with linseed oil. They used the "glass plate" method, and their results indicated that lumbang oil compares favorably with linseed oil in the rate of drying and quality of film.

⁵ Genthe, A., Zeits. für Angew. Chem. 19 (1906) 2087.

⁶ Richmond, G. F., and Rosario, M. V. del, Philip. Journ. Sci. § A 2 (1907) 439; Wilcox, E. V., and Thompson, A. R., Press Bull., Hawaii Agr. Exp. Station 39 (1913); Brill, H. C., and Agcaoili, F., Philip. Journ. Sci. § A 10 (1915) 111; Aguilar, R. H., Philip. Journ. Sci. § A 12 (1917) 235 and 14 (1919) 275; West, A. P., and Brown, W. H., Bull. P. I. Bur. Forestry 20 (1920) 121; West, A. P., and Montes, Z., Philip. Journ. Sci. 18 (1921) 619; West, A. P., and Gonzaga, L., Philip. Journ. Sci. 23 (1923) 277; West, A. P., and Smith, F. L. 2d., Bull. P. I. Bur. Forestry 24 (1923).

⁷ Brill, H. C., and Agcaoili, F., Philip. Journ. Sci. § A 10 (1915) 119.

⁸ Aguilar, R. H., Philip. Journ. Sci. § A 12 (1917) 237.

Various commercial products⁹ such as paints, varnishes, putties, soaps, and printing inks have been made from lumbang and linseed oils under identical conditions. Raw, boiled, and blown lumbang and linseed oils were used in making these various products. Boiled and blown oils containing driers were also employed. The results showed that the method of treatment, whether boiling or blowing with or without driers, affected both oils in apparently the same manner. As a drying oil, lumbang appeared to be just as good as linseed and either oil can be used as an efficient substitute for the other.

It is well known that the oxygen absorption of an oil is closely related to the iodine value; in fact, as pointed out by Lewkowitsch,¹⁰ a rough proportionality exists between the quantity of oxygen actually absorbed by an oil and the amount calculated by multiplying the iodine value by the factor 0.063. A determination of the iodine value of an oil that is being oxidized gives, then, an idea of the amount of oxygen absorbed. Experiments¹¹ have been carried out on the oxidation of lumbang oil by allowing a slow current of dried air to pass through the oil which was heated and stirred constantly. At frequent intervals samples of the oxidized oil were taken and determinations made of various constants such as the iodine and saponification values. As a result of continued oxidation a considerable quantity of volatile gases was evolved and the non-volatile portion of the oil became very thick and viscous. The specific gravity, acid, and saponification values increased, while the iodine value decreased.

Analyses of lumbang and linseed oils are given in Table 1. The composition of lumbang oil was determined by West and

TABLE 1.—*Composition of lumbang and linseed oils.*

| Glyceride. | Lumbang oil. | Linseed oil. |
|---------------------------|------------------|------------------|
| Unsaturated glycerides: | <i>Per cent.</i> | <i>Per cent.</i> |
| Linolenic..... | 6.5 | 39.7 |
| Linolic..... | 33.5 | 31.4 |
| Oleic..... | 57.0 | 18.3 |
| Saturated glycerides..... | ^a 2.8 | 9.7 |
| Total..... | 99.8 | 99.1 |

^a The figure 2.8 may perhaps represent oxidized glycerides.

⁹ West, A. P., and Smith, F. L. 2d, Bull. P. I. Bur. Forestry 24 (1923).

¹⁰ Lewkowitsch, J., Chemical Technology and Analysis of Oils, Fats, and Waxes 1 (1921) 478.

¹¹ West, A. P., and Montes, Z., Philip. Journ. Sci. 18 (1921) 619.

Montes¹² who used the lead-salt-ether method¹³ to separate the saturated from the unsaturated acids in lumbang oil, and the bromo-derivative method¹⁴ to separate the unsaturated acids from each other. In this analysis of lumbang oil the percentage of saturated glycerides is given as 2.8. In making this analysis no special precautions were taken to protect the solutions and perhaps the glycerides, reported as saturated, were really oxidized glycerides which were formed during the analysis or were present in the original oil. The lead salts of the oxidized acids are insoluble in ether and, if oxidized acids are present, they would go with the saturated acids in the lead salt separation. Subsequent analyses of lumbang oil indicated that these glycerides were perhaps not saturated, but rather oxidized compounds. Lewkowitsch¹⁵ records various analyses of linseed oil, one of which, given in Table 1, was worked out in round numbers of Fahrion. His results, expressed in percentage of acids, have been recalculated to the glycerides originally present in the oil. In this analysis of linseed oil the percentage of linolenic glyceride is given as 39.7 which is equivalent to 38 per cent linolenic acid. This figure would seem, however, to be entirely too high, since Lewkowitsch¹⁶ found, by determining the ether-insoluble bromides of linseed oil, only 15.4 per cent of linolenic acid.

SAMPLES

The lumbang oil used in this investigation was the ordinary first-grade, raw oil purchased from one of the Chinese oil dealers in Manila. The raw linseed oil was obtained from one of the drug companies in Manila. Data on these samples are given in Table 2.

TABLE 2.—*Constants of lumbang and linseed (raw) oils.*

| Constants. | Lumbang oil | Linseed oil. |
|------------------------------|--|--|
| Specific gravity..... | 0.92292 ($\frac{27.4^{\circ}}{4^{\circ}}$) | 0.92576 ($\frac{28.4^{\circ}}{4^{\circ}}$) |
| Refractive index (Abbé)..... | 1.4733 (33.1°) | 1.4788 (26.3°) |
| Iodine value (Hübl)..... | 144.6 | 165.5 |
| Surface tension (Dynes)..... | 36.9 | 35.3 |

¹² West, A. P., and Montes, Z., *Philip. Journ. Sci.* **18** (1921) 630.

¹³ Lewkowitsch, J., *Chemical Technology and Analysis of Oils, Fats, and Waxes* 1 (1921) 556.

¹⁴ *Op. cit.* 585.

¹⁵ Lewkowitsch, J., *Chemical Technology and Analysis of Oils, Fats, and Waxes* 2 (1914) 62.

¹⁶ *Op. cit.* 60.

PROCEDURE

In carrying out the oxidation experiments a measured quantity of dried air was passed through a small gas wash bottle containing lumbang oil which was heated in a bath to a temperature of 75°. The excess of air which passed through the oil was then conducted through various absorption tubes. At stated intervals the oxidation was discontinued temporarily and the amount of oxygen that reacted with the oil was determined by weighing the vessel containing the oil and the tubes which absorbed the gases escaping from the oil. For comparative data we treated linseed oil in the same manner and used the same gas wash bottle that was employed for determining the oxygen absorption of lumbang oil. Samples of lumbang oil were also oxidized in the same manner for definite periods of time after which the oxidized samples were analyzed. The results of the changes in lumbang oil caused by slow oxidation were calculated from the data thus obtained.

The air used for oxidation was obtained from a large sulphuric acid carboy by allowing a current of water to enter through a tube reaching to the bottom, the air being expelled from the top of the carboy as the water gradually rose. The air was then passed through a Drechsel wash bottle containing sulphuric acid and then through three soda lime tubes and one calcium chloride tube, after which it entered the oil. After the current of air had passed through the oil it was allowed to flow through two small wash bottles containing concentrated sulphuric acid, a tube containing solid potassium hydroxide, three soda lime tubes, and two calcium chloride tubes. Two carboys were used for generating the supply of air. The water used for expelling the air from the carboys was obtained from a constant level tank placed above the carboys and the flow of water was controlled by means of a two-way stopcock. Each carboy was calibrated and had a graduated scale attached to indicate the approximate volume of air entering the oil.

The bath, in which the weighed vessel containing the lumbang oil was immersed, was stirred by a hot-air motor and the temperature was controlled accurately at 75° by a thermo regulator. The bath was covered during the periods of oxidation, so as to prevent the access of light and thus eliminate the influence of this variable factor which, as Genthe¹⁷ showed, accelerates the oxidation reaction.

¹⁷ Genthe A., *Zeits. für Angew. Chem.* 19 (1906) 2090.

The entire oxidation apparatus is illustrated by photographs, here reproduced as Plate 1.

RESULTS

When linseed oil is blown, not only is oxygen absorbed by the oil forming nonvolatile products, as in drying, but a portion of the oil reacts with oxygen to form volatile products which escape. Lumbang oil behaves in a similar manner when blown. These drying oils, therefore, not only tend to gain in weight due to absorbed oxygen (apparent oxygen absorption), but also tend to decrease in weight due to escaping volatile products. The total amount of oxygen which gradually reacts with the constituents in the oil during the blowing process may be determined by weighing the vessel containing the oil and the tubes which absorb the gases escaping from the oil.¹⁸ Data showing the apparent oxygen absorption, volatile products evolved, and the total oxygen absorption of lumbang oil blown for one hundred hours at 75° are given in Table 3. For comparison we treated linseed oil in the same manner and the data are given in Table 4.

TABLE 3.—*Oxygen absorption of lumbang oil blown for various periods at 75°.*

[Weight of oil used, 44.8633 grams.]

| Period blown. | Approximate volume of air used. | Increase in weight of oil (apparent oxygen absorption). | | Weight of volatile products. | | Total oxygen absorption. | |
|---------------|---------------------------------|---|-----------|------------------------------|-----------|--------------------------|-----------|
| Hours. | Liters. | Grams. | Per cent. | Grams. | Per cent. | Grams. | Per cent. |
| 10..... | 212 | 0.2113 | 0.47 | 0.2006 | 0.45 | 0.4119 | 0.92 |
| 20..... | 423 | 0.7132 | 1.59 | 0.4379 | 0.98 | 1.1511 | 2.57 |
| 30..... | 634 | 1.0567 | 2.35 | 0.8075 | 1.80 | 1.8642 | 4.15 |
| 40..... | 839 | 1.3048 | 2.96 | 1.0656 | 2.32 | 2.3704 | 5.28 |
| 60..... | 1,260 | 1.7258 | 3.85 | 1.7103 | 3.81 | 3.4361 | 7.66 |
| 80..... | 1,673 | 2.0132 | 4.49 | 2.3727 | 5.29 | 4.3859 | 9.78 |
| 100..... | 2,099 | 2.1168 | 4.72 | 3.0600 | 6.82 | 5.1768 | 11.54 |

The data given in Tables 3 and 4 show that in the early stages of oxidation (blowing) the percentage of apparent oxygen absorption, volatile products evolved, and total oxygen absorption are greater for lumbang than for linseed oil. These figures are cumulative; that is, the figure 4.15 (Table 3) represents the total percentage of oxygen absorption of lumbang oil blown for thirty hours. As the oxidation process continues the velocity of oxy-

¹⁸ Friend, J. N., *The Chemistry of Linseed Oil* (1917) 48.

gen absorption increases more rapidly for linseed than for lumbang oil until at one hundred hours the percentage of total oxygen absorption of linseed is greater than that of lumbang.

TABLE 4.—Oxygen absorption of linseed oil blown for various periods at 75°.

[Weight of oil used, 45.1078 grams.]

| Period blown. | Approximate volume of air used. | Increase in weight of oil (apparent oxygen absorption). | | Weight of volatile products. | | Total oxygen absorption. | |
|---------------|---------------------------------|---|-----------|------------------------------|-----------|--------------------------|-----------|
| | | Grams. | Per cent. | Grams. | Per cent. | Grams. | Per cent. |
| 10 | 212 | —0.0130 | 0.03 | 0.1130 | 0.25 | 0.1000 | 0.22 |
| 30 | 634 | —0.0132 | 0.03 | 0.5931 | 1.32 | 0.5799 | 1.29 |
| 40 | 839 | 0.3106 | 0.69 | 0.8421 | 1.87 | 1.1527 | 2.56 |
| 60 | 1,260 | 0.9224 | 2.04 | 1.4587 | 3.24 | 2.3811 | 5.28 |
| 80 | 1,673 | 1.4170 | 3.14 | 2.2767 | 5.05 | 3.6937 | 8.19 |
| 100 | 2,099 | 2.0798 | 4.61 | 3.4821 | 7.72 | 5.5619 | 12.33 |

TABLE 5.—Total percentage of oxygen absorption per hour during different periods in the oxidation of lumbang and linseed oils blown at 75°.

| Period. | Lumbang oil. | Linseed oil. |
|-----------|--------------|--------------|
| Hours. | Per cent. | Per cent. |
| 0 to 10 | 0.092 | 0.022 |
| 10 to 30 | 0.161 | 0.053 |
| 30 to 40 | 0.113 | 0.127 |
| 40 to 60 | 0.119 | 0.136 |
| 60 to 80 | 0.106 | 0.145 |
| 80 to 100 | 0.088 | 0.207 |

Data showing a comparison of the relative velocity of oxygen absorption of lumbang and linseed oils are given in Table 5. These figures, giving the total percentage of oxygen absorption per hour during definite periods of time, indicate that for about the first thirty hours lumbang oil absorbs oxygen much more rapidly than does linseed oil. After thirty hours of oxidation the absorption velocity of lumbang gradually decreases while there is a very considerable increase in the absorption velocity of linseed. Both oils have approximately the same absorption velocity for the period of oxidation extending from about thirty to forty hours. With linseed oil, the velocity of oxygen absorption increases continually up to a period of one hundred hours at which time the oxidation experiments were discontinued.

Analyses of lumbang and linseed oils, given in Table 1, show that both oils consist of a mixture of unsaturated glycerides

(linolenic, linolic, and oleic) and contain also glycerides of saturated acids. Linseed oil contains a much larger percentage of linolenic glyceride and also of the saturated glycerides than does lumbang oil. The saturated glycerides have no particular drying power and are generally regarded as undesirable constituents in drying oils. Perhaps the saturated glycerides exert a retarding influence and, since lumbang contains a much smaller proportion of saturated glycerides (retarders) than does linseed, the velocity of oxygen absorption in the early stages of oxidation is therefore much greater for lumbang than for linseed.

With linseed oil the velocity of oxygen absorption is very slow for about the first thirty hours, due possibly to the retarding influence of the saturated glycerides, and after that time the absorption velocity increases considerably. It may be, as some authorities believe, that in the early stages of oxidation autocatalysts are formed and these substances accelerate the absorption velocity. Linseed oil contains a considerable quantity of linolenic glyceride which, as will be shown later, absorbs oxygen much more readily than does either linolic or oleic glyceride. Possibly after about thirty hours of oxidation a sufficient quantity of autocatalysts has accumulated to overcome the retarding influence of the saturated glycerides as well as to exert a marked autocatalytic influence on the absorption velocity of the unsaturated glycerides, particularly the highly unsaturated linolenic glyceride.

Perhaps autocatalysts are formed in both lumbang and linseed oils. The autocatalyst, if present, in lumbang oil may be effective for the first thirty hours because no considerable quantity of saturated glycerides (retarders) is present. Lumbang oil contains only 6.5 per cent of linolenic glyceride, which is the most active absorber of oxygen. As shown later, a considerable proportion of this is oxidized during the first thirty hours of oxidation and after that time the quantity of linolenic glyceride that remains is probably so small that the oxidation of this particular glyceride does not produce a very marked effect upon the oxidation of the entire oil. Although the autocatalysts may still tend to accelerate the oxygen absorption of linolic and oleic glycerides, these substances naturally absorb oxygen much more slowly than does linolenic glyceride and, perhaps, the effect of these compounds on the total oxygen absorption of the oil is not sufficient to increase the rate of total oxygen absorption after thirty hours. The result is that the figures showing the per-

centage oxygen absorption per hour (Table 5) of lumbang oil increase up to thirty hours due, perhaps, to autocatalysis and the absence of retarders, and after that they decrease due, possibly, to an insufficiency of linolenic glyceride and also to the slow absorption of oxygen by linolic and oleic glycerides.

CONSTANTS OF OXIDIZED OILS

Constants of samples of lumbang and linseed oils blown for various periods of time at 75° are given in Table 6. The iodine values were determined by means of the Hübl method. Surface-tension measurements were made with the Du Nouy surface-tension apparatus. As shown by the data both lumbang and linseed oils gave very similar results. By continued blowing the surface-tension and refractive index (Abbé) of both oils increased slightly, while the iodine values of both oils decreased considerably.

TABLE 6.—*Iodine value, refractive index (Abbé), and surface tension (Du Nouy) of lumbang and linseed oils blown at 75°.*

| Period blown. | | Iodine value (Hübl). | | Surface tension at 28°. | |
|---------------|---------|----------------------|--------------|-------------------------|--------------|
| | | Linseed oil. | Lumbang oil. | Linseed oil. | Lumbang oil. |
| Hours. | Liters. | | | Dynes. | Dynes. |
| 0 | 0 | 165.5 | 144.6 | 35.3 | 36.9 |
| 20 | 400 | 160.5 | 133.1 | 36.7 | 37.6 |
| 40 | 781 | 142.6 | 119.1 | 37.4 | 38.0 |
| 60 | 1,276 | 122.6 | 102.4 | 38.2 | 38.4 |
| 80 | 1,652 | 109.1 | 91.1 | 38.8 | 38.7 |

| Period blown. | | Refractive index (Abbé). | | | |
|---------------|---------|--------------------------|-------------------|--------------|-------------------|
| | | Lumbang oil. | | Linseed oil. | |
| | | Temperature. | Refractive index. | Temperature. | Refractive index. |
| Hours. | Liters. | °C. | | °C. | |
| 0 | 0 | 33.1 | 1.4733 | 26.3 | 1.4788 |
| 20 | 400 | 32 | 1.4750 | 26.4 | 1.4796 |
| 40 | 781 | 32 | 1.4769 | 26.3 | 1.4821 |
| 60 | 1,276 | 32 | 1.4788 | 26.4 | 1.4844 |
| 80 | 1,652 | 32 | 1.4800 | 26.4 | 1.4858 |

ANALYSIS OF OXIDIZED OILS

To ascertain the relative oxidation of the various unsaturated compounds in lumbang oil, samples of the oil were oxidized for definite periods of time and the composition of the unoxidized portion of the oxidized samples was determined by analysis. The analytical procedure consisted in converting the oxidized glycerides into their corresponding oxidized acids, separating the oxidized acids by a modification of Fahrion's method,¹⁹ and determining the proportions of unoxidized linolenic, linolic, and oleic acids by means of the bromo-derivative method.²⁰

In separating the oxidized acids by a modification of Fahrion's method the oxidized oil was saponified in the usual manner and the alcohol eliminated by distilling. The resulting soaps were then decomposed by dilute hydrochloric acid and the total acids extracted twice with ether. The ethereal solution was dehydrated with anhydrous sodium sulphate, filtered, and the ether was removed by distillation. The total acids were then heated (reflux) for an hour with about 200 cubic centimeters of petroleum ether (boiling point, 35° to 50°), cooled, and the mixture treated with anhydrous sodium sulphate which facilitates the precipitation of colloidal oxyacids. The mixture was then shaken thoroughly and allowed to stand about two hours. The oxyacids, which had a brown, sticky, jellylike appearance, adhered to the sides of the flask. The mixture was filtered and the filter paper returned to the flask containing the sticky oxyacids. The oxyacids were then dissolved in ether, the ethereal solution was filtered into a weighed flask, and the ether eliminated by distillation.

The petroleum ether solution containing the unoxidized acids was transferred to a weighed flask, and the unoxidized acids were separated from the solvent by distilling.

Samples of lumbang oil oxidized for various periods of time were analyzed according to this modification of Fahrion's method. The results are recorded in Table 7.

When lumbang oil is oxidized the percentage of oxidized glycerides increases while the percentage of unoxidized (unsaturated) glycerides decreases. This fact is brought out very clearly by the data given in Table 7, which show that the percentage of oxidized acids, corresponding to the oxidized glyc-

¹⁹ Lewkowitsch, J., *Chemical Technology and Analysis of Oils, Fats, and Waxes* 1 (1921) 593.

²⁰ *Op. cit.* 585.

erides, gradually increases while the percentage of unoxidized (unsaturated) acids, corresponding to the unsaturated glycerides, decreases. The results show, approximately, the relative proportions of oxidized and unoxidized constituents in lumbang oil blown for various periods of time.

TABLE 7.—Separation of oxidized and unoxidized (unsaturated) acids from lumbang oil blown at 75° by Fahrion's method, modified.

| Sample No. | Period blown. | Approximate volume of air used. | Oxidized acids. | Unoxidized (unsaturated) acids. | Total acids. |
|------------|---------------|---------------------------------|-----------------|---------------------------------|--------------|
| | Hours. | Liters. | Per cent. | Per cent. | Per cent. |
| 1 | 0 | | 2.73 | 93.04 | 95.77 |
| 2 | 20 | 400 | 7.13 | 88.52 | 95.65 |
| 3 | 40 | 781 | 17.46 | 79.07 | 96.53 |
| 4 | 60 | 1,276 | 26.86 | 68.66 | 95.52 |
| 5 | 80 | 1,652 | 32.24 | 62.12 | 94.36 |

* The acids in this sample were separated by the lead-salt method.—West and Montes, Philip. Journ. Sci. 18 (1921) 625.

UNOXIDIZED (UNSATURATED) ACIDS

Samples of unoxidized (unsaturated) acids separated by a modification of Fahrion's method were analyzed by the bromoderivative method, which is used to separate the various unsaturated acids from each other. The bromine addition products of the unsaturated acids were prepared by dissolving a portion of the unsaturated acids in ether; the ethereal solution was cooled to a temperature of -10° and bromine was added slowly, after which the solution was allowed to stand about three hours at -10° . The crystals of linolenic hexabromide thus obtained were filtered through a weighed filter paper. The filtrate from the hexabromide was shaken in a separating funnel with 10 per cent sodium thiosulphate solution to remove the excess bromine, after which the separated ethereal solution was dehydrated with anhydrous sodium sulphate, filtered, and distilled to eliminate the ether. The residue that remained was then treated with petroleum ether (boiling point, 35° to 50°) and the mixture heated (reflux) about one hour. The mixture was then cooled, and the crystals of linolic tetrabromide were separated by filtration. By concentrating the petroleum ether filtrate to a volume of about 150 cubic centimeters and allowing the solution to stand overnight, a second crop of tetrabromide crystals was obtained.

The petroleum ether filtrate from the crystalline linolic tetrabromide was concentrated to a volume of about 100 cubic centi-

meters, transferred to a small distilling flask which had been previously weighed, and the solution distilled in vacuum until no more petroleum ether passed over. The dark residue thus obtained was then weighed and the bromine content determined. The bromine content of linolic tetrabromide is 53.33 per cent; and of oleic dibromide, 36.18 per cent. Knowing the bromide content of the residue, the percentages of linolic tetrabromide and of oleic dibromide can be calculated readily.

The results of analyzing the unoxidized (unsaturated) acids separated from samples of lumbang oil blown for twenty and sixty hours are given in Tables 8 and 9, respectively.

Lumbang oil blown for twenty hours, when analyzed by a modification of Fahrion's method, gave 7.13 per cent of oxidized acids and 88.52 per cent of unoxidized (unsaturated) acids. When blown for sixty hours, analysis of the oil gave 26.86 per cent oxidized acids and 68.66 per cent unoxidized (unsaturated) acids (Table 7). The unsaturated acids, when analyzed by the bromo-derivative method and the results calculated as glycerides originally present in the oil, gave the data recorded in the last column of Tables 8 and 9, and also in Table 10. The oxidized

TABLE 8.—Analysis of unoxidized (unsaturated) acids separated from lumbang oil which was blown for twenty hours at 75° (bromo-derivative method).

| | Grams. |
|---|--------|
| Sample of liquid acids..... | 2.0308 |
| Hexabromide (ether-insoluble bromide)..... | 0.3080 |
| First crop of tetrabromide..... | 0.0216 |
| Second crop of tetrabromide..... | 0.3062 |
| Residue (dibromide and tetrabromide; bromine content, 42.66 per cent).... | 3.0788 |
| Dibromide in residue..... | 1.9150 |
| Tetrabromide in residue..... | 1.1640 |
| Total tetrabromide found..... | 1.4918 |
| Linolenic acid equivalent to hexabromide..... | 0.1131 |
| Linolic acid equivalent to tetrabromide..... | 0.6963 |
| Oleic acid equivalent to dibromide..... | 1.2220 |

CALCULATION OF UNSATURATED ACIDS TO GLYCERIDES ORIGINALLY PRESENT IN THE OIL.

| Acid. | Mixture of unsaturated acids. | Unsaturated calculated on basis of original oil. | Unsaturated glycerides in original oil. |
|----------------|-------------------------------|--|---|
| | Per cent. | Per cent. | Per cent. |
| Linolenic..... | 5.56 | 4.92 | 5.14 |
| Linolic..... | 34.28 | 30.34 | 31.71 |
| Oleic..... | 60.15 | 53.24 | 55.64 |

acids, separated by Fahrion's method (Table 7), were calculated as glycerides by using the factor 1.04, which is the factor for converting oxylinolic acid to oxylinolic glyceride. The results are recorded in Table 10.

TABLE 9.—Analysis of unoxidized (unsaturated) acids separated from lumbang oil which was blown for sixty hours at 75° (bromo-derivative method).

| | Grams. |
|--|--------|
| Sample of liquid acids | 3.3088 |
| Hexabromide (ether-insoluble bromide) | 0.1242 |
| First crop of tetrabromide | 0.0754 |
| Second crop of tetrabromide | 0.3430 |
| Residue (dibromide and tetrabromide; bromine content 41.78 per cent) | 5.1512 |
| Dibromide in residue | 3.4690 |
| Tetrabromide in residue | 1.6822 |
| Total tetrabromide found | 2.1006 |
| Linolenic acid equivalent to hexabromide | 0.0455 |
| Linolic acid equivalent to tetrabromide | 0.9805 |
| Oleic acid equivalent to dibromide | 2.2130 |

CALCULATION OF UNSATURATED ACIDS TO GLYCERIDES ORIGINALLY PRESENT IN THE OIL.

| Acid. | Mixture of unsaturated acids. | Unsaturated acids calculated on basis of original oil. | Unsaturated glycerides in original oil. |
|-----------------|-------------------------------|--|---|
| | Per cent. | Per cent. | Per cent. |
| Linolenic | 1.38 | 0.95 | 0.99 |
| Linolic | 29.63 | 20.35 | 21.27 |
| Oleic | 66.89 | 45.93 | 48.00 |

TABLE 10.—Composition of raw and blown lumbang oil.^a

| Constituent. | Raw oil. | Oil blown for twenty hours. | Oil blown for sixty hours. |
|---------------------------|-----------|-----------------------------|----------------------------|
| Unsaturated glycerides: | Per cent. | Per cent. | Per cent. |
| Linolenic | 6.5 | 5.1 | 1.0 |
| Linolic | 33.5 | 31.7 | 21.3 |
| Oleic | 57.0 | 55.6 | 48.0 |
| Oxidized glycerides | 2.8 | 7.4 | 27.9 |
| Total | 99.8 | 99.8 | 98.2 |

^a The composition of the raw oil was determined by West and Montes, Philip. Journ. Sci. 18 (1921) 633. The temperature of blowing was 75°.

The results given in Table 10 show that when lumbang oil is blown (oxidized) for various periods of time the percentage of oxidized glycerides increases while the percentage of unsaturated glycerides (linolenic, linolic, and oleic) decreases.

TABLE 11.—Percentage of unsaturated glycerides (linolenic, linolic, and oleic) oxidized during different periods at 75° and the percentage of these glycerides oxidized per hour during these periods.

| Glyceride. | Proportion of glyceride oxidized. | | | Percentage of glyceride oxidized per hour. | |
|--------------------|-----------------------------------|-------------------------|------------------------|--|-------------------------|
| | Period, 0 to 20 hours. | Period, 20 to 60 hours. | Period, 0 to 60 hours. | Period, 0 to 20 hours. | Period, 20 to 60 hours. |
| | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. |
| Linolenic. | 21.5 | 63.1 | 84.6 | 1.07 | 1.58 |
| Linolic. | 5.4 | 31.0 | 36.4 | 0.27 | 0.77 |
| Oleic. | 2.5 | 13.3 | 15.8 | 0.12 | 0.33 |

In Table 11 is given the percentage of unsaturated glycerides (linolenic, linolic, and oleic) oxidized during different periods of time. The data show that the more unsaturated glyceride is oxidized more readily than is the less unsaturated. This is what one would naturally expect if absorption of oxygen takes place at the double bonds and we assume that the formula of linolenic glyceride has nine double bonds; linolic glyceride, six double bonds; and oleic glyceride, only three double bonds.

Figures giving the percentage of each glyceride oxidized per hour (Table 11) show that the rate of oxidation (1.58 per cent) of linolenic glyceride for the period extending from twenty to sixty hours is less than double the rate (1.07 per cent) for the first twenty hours. Figures for linolic and oleic glycerides show that the rate of oxidation for the period extending from twenty to sixty hours is about three times the rate for the first twenty hours. These results would seem to indicate that, although the rate of oxidation of linolenic glyceride increases after twenty hours of oxidation, it does not increase as much as the oxidation rates of linolic and oleic glycerides. Since there is such a small percentage of linolenic glyceride in lumbang oil and as a considerable proportion of this is oxidized during the early stages of oxidation, possibly the increase in the rate of oxidation during the later stages is not as great as it would normally be if the oil contained more linolenic glyceride.

We have not as yet endeavored to get any data regarding the constitution of the oxidized compounds in blown lumbang oil or the compounds that are present in the volatile products. We expect to make investigations along these lines when time permits.

SUMMARY

When lumbang and linseed oils are blown under the same conditions at 75° the percentage of apparent oxygen absorption, volatile products evolved, and total oxygen absorption in the early stages of oxidation (blowing) are greater for lumbang than for linseed oil (Tables 3 and 4). As the oxidation process continues the velocity of oxygen absorption increases more rapidly for linseed than for lumbang oil until at one hundred hours the percentage of total oxygen absorption of linseed is greater than that of lumbang.

Data giving the total percentage of oxygen absorption per hour during definite periods of time, for lumbang and linseed oils (Table 5), indicate that for about the first thirty hours lumbang oil absorbs oxygen much more rapidly than does linseed oil. After thirty hours of oxidation the absorption velocity of lumbang gradually decreases while there is a very considerable increase in the absorption velocity of linseed. Both oils have approximately the same absorption velocity for the period of oxidation extending from about thirty to forty hours. With linseed oil, the velocity of oxygen absorption increases continually up to a period of one hundred hours at which time the oxidation experiments were discontinued.

Both linseed and lumbang oils consist of a mixture of unsaturated glycerides (linolenic, linolic, and oleic) and contain also saturated glycerides. Linseed oil contains a much larger percentage of linolenic glyceride and also the saturated glycerides than does lumbang. Possibly autocatalysts are formed in both lumbang and linseed oils and these substances tend to accelerate the velocity of oxygen absorption while the saturated glycerides that are present in these oils tend to retard the absorption velocity. Since lumbang oil contains a much smaller proportion of saturated glycerides (retarders) than does linseed oil, the velocity of oxygen absorption in the early stages of oxidation is much greater for lumbang than for linseed. With linseed oil, perhaps a sufficient quantity of autocatalysts accumulates, after thirty hours of oxidation, to overcome the retarding influence of the saturated glycerides and to exert a marked autocatalytic influence on the absorption velocity of the unsaturated glycerides, particularly the highly unsaturated linolenic glyceride. As a result, the figures showing the oxygen absorption velocity per hour (Table 5) of linseed oil increase considerably after thirty hours of oxidation.

Constants of samples of lumbang and linseed oils blown for various periods of time at 75° were determined. Both oils gave very similar results. By continued blowing the surface-tension and refractive index of both oils increased slightly while the iodine values of both oils decreased considerably.

Samples of lumbang oil oxidized for various periods of time were analyzed. The results showed that the percentage of oxidized glycerides increased while the percentage of unoxidized (unsaturated) glycerides decreased. The data also showed the relative oxidation of the various unsaturated glycerides in lumbang oil; linolenic glyceride was oxidized more readily than was linolic, and the latter was oxidized more readily than was oleic. If it is true that, in drying or blowing, absorption of oxygen takes place at the double bonds, then the more unsaturated the compound the more readily it should absorb oxygen. The experimental data obtained accord well with the formulas which have been suggested for these unsaturated glycerides that are contained in lumbang oil since linolenic glyceride is more unsaturated than linolic glyceride which, in turn, is more unsaturated than oleic glyceride.

We wish to express our thanks and appreciation to Mr. Arthur F. Fischer, director of the Philippine Bureau of Forestry, for the material used in this investigation and the assistance he has kindly given.

ILLUSTRATION

PLATE 1

FIG. 1. Apparatus used for oxidation of oils, front view.

. 2. Apparatus used for oxidation of oils, side view.



Fig. 1. Front view.

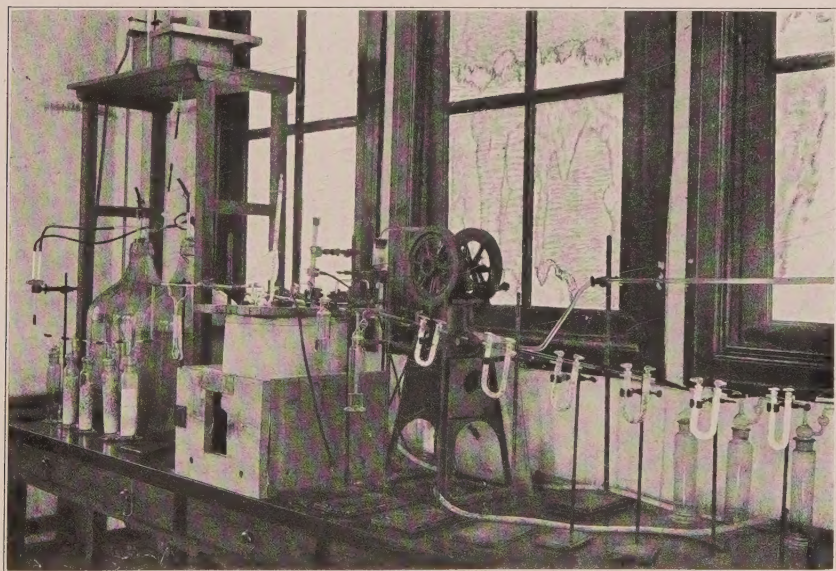


Fig. 2. Side view.

PLATE 1. APPARATUS USED FOR OXIDATION OF OILS.

